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AUTHOR Brinkworth, B. J.; Eckersall, K. E.
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ABSTRACT

A project was conducted to design and pilot a scheme for monitoring trade/industry/commerce technological changes and reporting them to Technical and Further Education (TAFE) teachers and authorities. A matrix of information categories was used to facilitate the collection and storage of information relative to technological advancements in the building, furniture, and plastics industries. The monitoring involved extensive literature searches and exchanges between industry contact persons and specialist technical monitors. Items were selected from among the information gathered and were published in the form of an illustrated news bulletin entitled Tech Info. The bulletin was distributed to 430 trade and technician building studies teachers throughout Australia for evaluation. Although responses to the questionnaire accompanying the bulletin were encouraging, their number was insufficient to draw any firm conclusions. It was discovered, however, that (1) a central library is very important for a monitoring scheme, (2) there are numerous advantages associated with beginning with an across-trades information-gathering approach and then resorting information into narrower categories, (3) cluster categories could be even more useful given a national agreement on nomenclature, and (4) an editorial group is essential to monitoring and reporting and should include a monitoring coordinator. (Appendixes include the first issue of Tech Info, the questionnaires sent to TAFE teachers and authorities, an information matrix, schemes for monitoring technology and technological change and reporting to TAFE personnel, and a bibliography). (MN)

TAFE NATIONAL CENTRE FOR
RESEARCH AND DEVELOPMENT

MONITORING TECHNOLOGICAL CHANGE

B.J. Brinkworth
&
K.E. Eckersall

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CONTENTS

SYNOPSIS

The project designed and piloted a scheme for monitoring trade/industry/commerce technological changes and reporting on them to TAFE teachers and Authorities.

A matrix of information categories was used to facilitate the collection and storage of information relevant to the building, furniture and plastics industries. Monitoring involved extensive literature searches as well as industry network contacts by specialist technical monitors. From the information collected, items selected were presented in the form of an illustrated news bulletin, which was issued for evaluation to 430 trade and technician building studies teachers throughout Australia.

The following conclusions were drawn:

- the matrix of categories developed is an appropriate aid to developing an information monitoring scheme;
- monitoring is very time-consuming but may become less so with experience;
- a central library facility is very important for the monitoring scheme;
- for collecting information, the evidence indicated clear advantages in beginning with 'across trades' categories (equipment, materials, processes, products, etc.) and then re-sorting the information using trade/industry/commerce 'clusters' (building, furnishing, engineering, printing, business/secretarial, etc.), than to begin to search from particular trades;
- such 'cluster' categories are important and useful but would become more so given national agreement on nomenclature;
- an editorial group is essential to monitoring and reporting and should include the monitoring co-ordinator;
- the printed bulletin produced was very useful and highly acceptable to the TAFE teacher group in quality, content and style.

Originally it was intended to provide supplementary information for TAFE Authorities, drawing attention to implications for planning, curricula, staff development, facilities and resources. This was not done because the sample reported in the pilot project was deemed insufficient to support significant inferences for the TAFE system.

Instead, a newsletter was sent to a sample of TAFE Authority officers outlining the potential of the monitoring scheme and a range of services that could be based on it.

Responses to an accompanying questionnaire were encouraging but insufficient to form a basis for firm conclusions. An outline of the proposed total scheme is included with this report.

1. PROJECT OVERVIEW

1.1 Background

The present project was a direct outcome of Pulsford's (1984) occasional paper which aimed to stimulate discussion concerning techniques for managing and implementing the collection of technological change information; collection 'to include the identification of the needs for information, and the dissemination of collected and analysed information to those who need it' (p. vii), including personnel in TAFE teaching, curriculum, staff development, planning, equipment, personnel and policy sectors.

1.2 Rationale

TAFE Authorities and teachers urgently need information about current, relevant industry/commerce technological changes. As a step towards designing a full-scale scheme for meeting the need, the project was intended to produce sample information, so that (i) a means of producing that information could be trialled, and (ii) the acceptability of information of the kind produced could be evaluated.

1.3 Objectives

It was envisaged that this pilot project would be the first of three relating to monitoring technological change, viz. (i) pilot project, (ii) development project and (iii) implementation project.

Objectives of this pilot project were to:

1.3.1 collect information about new technologies being introduced into two particular industries - building and furniture trades, and plastics;

1.3.2 analyse and process the information for two groups - (i) TAFE trade and technician teachers and (ii) TAFE Authorities;

1.3.3 disseminate the information to a sample of the above groups;

1.3.4 evaluate the effectiveness of the monitoring processes and the quality of the products of the trial. (It was not envisaged that this evaluation would include costing or cost-benefit analysis.)

On the basis of the outcomes of this pilot project, the development project would identify information needs, methodologies for information collection from a full range of industry/commerce fields, data base arrangements for storing, retrieving and analysing information and appropriate processes for disseminating the information. The implementation project would flow from this.

1.4 Scope

This pilot project focused sharply on each of the above objectives, particularly in respect of technological change information collected for, and issued to, TAFE trade and technician teachers. However, in the course of the project, a broader scheme, for monitoring technological change and disseminating information was envisaged - including on-line facilities and a variety of services. This scheme, although strictly lying beyond the present project, is briefly outlined in Appendix H.

1.5 Design

The following sequence was proposed for the project design.

1.5.1 A monitoring unit is set up, incorporating the following personnel and functions:

- a unit co-ordinator interacts with a technical specialist (monitor) appointed from each given industry area and a library person;
- the monitor gleans new technology information from selected printed sources (usually journals) and oral sources (usually industry contacts);
- the library person provides backing support by directing relevant journals to monitors and providing information from abstracts, data bases, etc;
- the monitor analyses new technology information;
- the monitor channels information through the co-ordinator in an appropriate form for dissemination to teachers;
- the co-ordinator arranges for monitoring of information from a TAFE (Authority) planning viewpoint;
- the co-ordinator organises dissemination of information to a sample of the two recipient groups: a newsletter to TAFE Authorities, which could highlight any system-wide planning implications of the information reported, and a bulletin to TAFE trade teachers, which would contain more technical content directly relevant to their teaching.

1.5.2 Evaluation procedures - process and product - are set in train.

1.5.3 Report is produced, including an analysis of the monitoring process.

1.6 Survey of literature

The literature survey that follows below (Chapter 4) was produced to address issues including: definitions of technology/technological change; anticipating skill requirements in the light of industry's adoption of new technologies; technological change implications for TAFE; technological change information needs of TAFE Authorities and teachers; systems for providing, monitoring and processing technological change information; and prediction issues.

1.7 Processes

The sequence of events in developing the pilot project was as follows.

1.7.1 Appointment of monitoring unit: unit co-ordinator, specialist technical monitors and (later) bulletin editor.

1.7.2 'Brainstorm' to identify project objectives, background issues and methodology/design.

1.7.3 Project planning - including rationale, literature review, pre-data collection, project materials, evaluation and reporting.

1.7.4 Consideration of models for collecting data by monitors and library staff, including approaches suggested in documents, External Information Needed by TAFE and Collecting Technological Change Information for TAFE.

1.7.5 The project plan was developed including:

(a) a format of an information matrix for collating data, with the view to possible use of a computer at a later stage;

(b) an operational diagram and time-line, including considerations of methods of reviewing and collecting data, index of sources, storage in a data bank, and processes for review and evaluation;

(c) implementation and monitoring of the project, including considerations of role of monitors and library resource personnel, scope of material to be reviewed, newsletter preparation and evaluation, and final report.

1.7.6 A bibliography and survey of literature dealing with technological change were developed.

1.7.7 Monitors collected, analysed and evaluated technological change information in

(a) plastics - per trade/industry associations, trade journals, data search through RMIT, Pergamon Info Line, Dialog Information Services;

(b) furniture trades - per trade journals, trade/industry contacts (local and overseas);

(c) building trades - per trade/industry associations, literature search through RMIT, search of data bases in USA through CSIRO, industry contacts (interviews).

A library staff member was 'attached' to each monitor to assist with searches.

1.7.8 The respective formats of the TAFE teachers' Tech Info bulletin and the TAFE Authorities' newsletter were developed, in consultation with a graphic designer. The formats chosen were a two-colour, six-page TAFE teachers' bulletin and a one-colour, two-page TAFE Authorities' newsletter.

1.7.9 For the publication of the Tech Info teachers' bulletin (Appendix A), extensive editorial work was done on the materials supplied by monitors.

1.7.10 Evaluation processes for the TAFE teachers' bulletin were developed: a Tech Info bulletin to be sent with a questionnaire (Appendix B) to all Victorian TAFE trade and technician building studies teachers and a sample of teachers interstate - 430 in all; and personal contact to be made with teachers in two or three building studies departments. However, the latter step was not carried out since the information received from the survey was clear and conclusive.

1.7.11 The format and content of the TAFE Authorities' newsletter were developed, in consultation with officers of the Victorian TAFE Board.

(The initial intention had been to provide a newsletter which would draw attention to the implications of technological change information gathered and analysed for the teacher groups. This was not followed through because the sample was not considered broad enough to yield reliable implications applicable to 'system' wide activities.

A meeting with the Victorian TAFE Board officers provided a forum to obtain their reactions to the Tech Info bulletin and their advice on the most suitable information that would be of value to TAFE Authorities in other States. After discussing the concept of the total scheme, and being encouraged by their full support and enthusiasm for the services that would be

available, it was determined that the newsletter should outline the broad scheme and its services, and seek interstate TAFE Authorities' reactions via a survey.)

1.7.12 Evaluation processes for the TAFE Authorities' newsletter were developed - a newsletter, together with the Tech Info teachers' bulletin, and a questionnaire to be sent to TAFE staff development, curriculum, facilities planning, field services and policy and planning officers in each State (Appendix D).

1.7.13 Questionnaire replies from TAFE teachers and Authorities were collated and analysed to find the implications for the pilot project and the possible stages 2 and 3 projects.

1.7.14 Data bank storage and retrieval and videotex dissemination facilities were investigated.

1.8 Elaboration of the monitoring process

The approaches used for the monitoring process were planned by the project leaders, the three monitors and library support staff.

Three methods were used, the first of which was based on a literature survey.

The agreed procedure was:

(a) to identify the most likely technical/trade journals for each of the three areas under consideration;

(b) to use library support in obtaining these journals over a 12-24 month period - in this case, they had to be back copies, whereas the final scheme would monitor on a regular basis;

(c) to use the specialist monitors to read the journals with the aim of identifying new technology or trends which could establish changes in technology, materials, processes or products;

(d) to extend the range of information identified in (c) by having the specialist monitors carry out further investigations via:

(i) literature searches using computer services available at RMIT and CSIRO,
(ii) human resource networks such as: interviewing experts in the field, industrial contacts, specialists, industry/trade/technology displays and exhibitions,
(iii) other printed resources;

(e) to have the specialist monitors:

(i) develop comprehensive bibliographies,
(ii) write abstracts,
(iii) write articles suitable to inform trade/technician teachers in the field;

(f) to identify implications for TAFE Authorities.

This approach was implemented and considerable time and effort went into 'tracking down' journals and sorting them for general suitability. At least three literature searches were made using the RMIT computer service, and extensive use of the CSIRO's library service provided both lists of possible Australian and overseas publications and samples of many of the journals.

Another method used a direct personal approach to known research and information sources, in this case the CSIRO. It was considered that we should not try to 're-invent the wheel', but rather use existing information gathered by groups such as the CSIRO, the Australian Bureau of Statistics and the Australian Science and Technology Council.

The third method used the industry contact/industry visit approach. In one case, the monitor interviewed an industry contact - the managing director of an Australian firm manufacturing specialist technical equipment - considering that he would be likely to know the 'state of the art'. In a second instance, the monitor put to use notes he had recently taken on visits to plants and trade exhibitions in Europe.

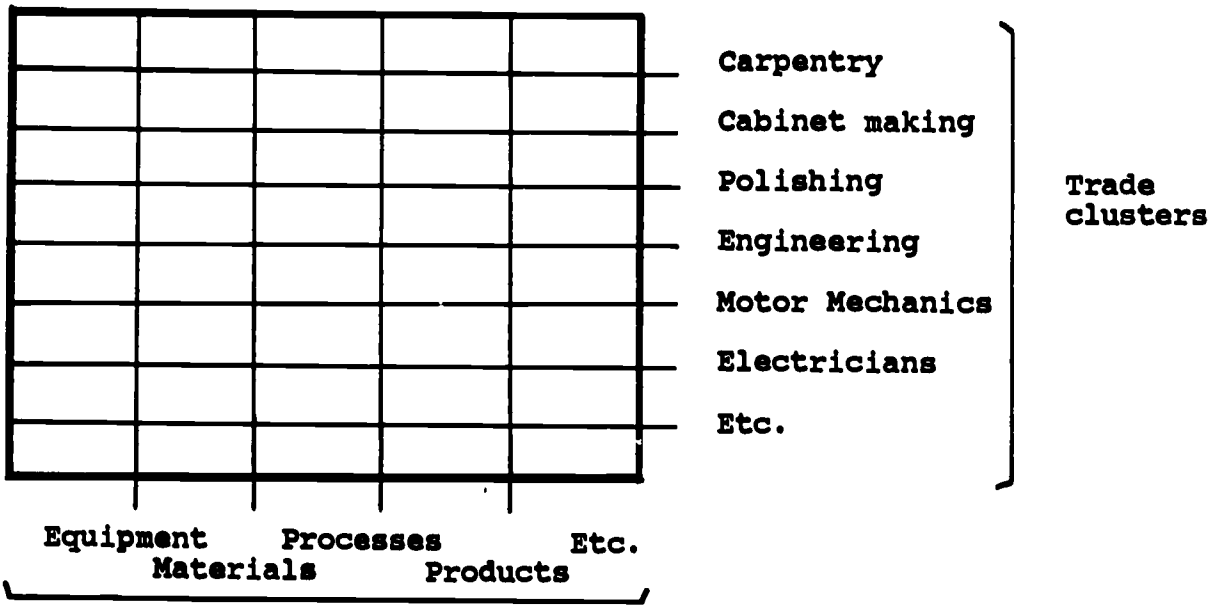
The learning outcomes gained by the monitors from their experiences of trialling this process have provided the basis for a more effective approach. It is important to stress the specialist monitors' own human resource networks for providing directions and contacts for further in-depth investigations. For example, the building trades specialist monitor's network encompassed interactions with: the building industry including sub-sectors (housing, multi-storey commercial); industry-related groups such as new product development, materials/product testing, product display; and trade teachers' and building studies teachers' associations.

Findings and evaluations of the process are provided in Chapter 2, and a refined monitoring process is detailed in the scheme outlined in Appendices F, G and H.

2. PROCESS AND PRODUCT EVALUATION

2.1 Monitoring process

In developing the monitoring process, we decided to consider the technological information requirements that would be desirable for a total monitoring system. We found this information could be separated into two major categories, information which was specifically related to known trade classifications and information which was related across trade boundaries. Consequently, the information matrix emerged as an ideal framework on which to design the monitoring process.



Note: Example classifications.

Figure 1: Information Matrix

The pilot project trialled the matrix structure by using a 'mini' matrix, consisting of two rows, building trades and furnishing trades, and three columns, plastics (representing materials) and lasers and computers (representing equipment). For the rows, trades were combined to form 'clusters', because of the large number of individual trade areas and the degree of commonality between their activities.

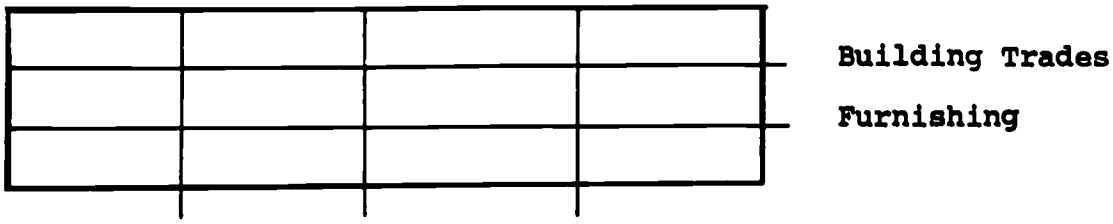


Figure 2: Trial project 'mini' information matrix

Specialist technical monitors from the building and furniture trades and the plastics (materials) area searched, collected, sorted, analysed and evaluated technological information, with support from library personnel.

2.2 Findings: monitoring process

Monitors working from the trade-related clusters in building and furnishing trades had difficulty in finding a starting point. There were innumerable possibilities. For example, in furnishing there were, among other things, fasteners (screws), adhesives, materials (laminates), laser cutting and numerical control machines. One monitor's comment sums up the frustration experienced: 'After wading through so much material I finally concluded I didn't know what to focus on'.

On the other hand, the monitor for materials (an across-trade classification) had no trouble in focusing on new information about where plastics were being used in the building and furnishing trades. This monitor's experience clearly showed benefits of beginning from across-trade classifications. This procedure was seen as being basic to the entire monitoring process. In fact, there was ample evidence generated which supported its wide application in many other trade areas. For example, hindsight tells us that had the building trades monitor selected an across-trade element first, focusing directly on lasers, the monitoring process would have been simplified.

So then, the ideal monitoring process that emerged was:

(a) general monitoring aides (e.g. library staff) may operate with an across-trade orientation and then rough-sort items into trade clusters;

(b) specialist monitors should choose particular across-trade classifications as a focus for collecting information as a basis for further investigation.

2.3 A summary of monitors' findings

- the limitations of books as resources
- the shortcomings of data searches - the problem mainly being attributed to imprecise 'descriptors'
- interviews a very useful source
- the importance of library back-up assistance
- the need to gain access to many more journals (cost implications)
- the need for a central resource
- the problems associated with trade monitors' time-consuming role: this would be reduced in future from experience gained from trial
- lists for searches become very long unless they focus on particular across-trade classifications
- only raw data need be collected and presented for editorial 'treatment', e.g. making a précis, summarising, abstracting
- the important role of 'specialist' trade experts in selecting and evaluating material in final form
- 'gaps' in information a problem, e.g. plastics monitor identified ample information on the technology but little information available on practical application.

2.4 Editorial role

The editorial role that emerged in the trial project was significant and it clearly established the need for an editorial group to be involved in any large-scale scheme. It ensures quality control and uniform style and consistency in providing output information for the designated target group.

The specific skills in writing and graphic design required to produce the information in the form most acceptable to the reader group are best provided by the editorial group, leaving the specialist monitors to concentrate both their time and effort in seeking, interpreting and analysing information.

2.5 Evaluation of the Tech Info bulletin for TAFE teachers

The bulletin was individually distributed by mail to 430 trade, technician and middle-level teachers involved in building and furniture studies throughout Australia; 270 within Victoria and 160 spread across major TAFE colleges in all other States.

The number of questionnaires returned at the time of compilation was 169, representing a high 39.3 per cent return; a further 31 returns followed after this date, but they were not included in the data findings (although they indicated the same overall trends). In all, 46.5 per cent is a high return rate for an interstate survey of this type and may be taken to indicate the degree of interest and the need for technological information by these teachers generally.

	Carpentry	Furnishing	Middle-Level	Total	
				No	%
Victoria	47	25	20	92	34
Other States*	25	29	23	77	48
Totals	72	54	43	169	39.3

*Includes returns from Queensland, New South Wales, Tasmania, South Australia, Western Australia and Australian Capital Territory.

Figure 3: Returns by teaching areas and States

The questionnaire was developed to:

(1) obtain feedback about the Tech Info bulletin from the clients for whom it was written;

(2) obtain data about their preferences among resource materials they use for gathering technological information.

Initially, the returns were classified into three teacher categories (carpentry, furnishing trades, middle-level studies), and the outcomes from each identified the same trends with no significant differences between the teacher groups. The data were then processed as a total group and the following information is based on an analysis of all the returns combined (see Appendix C for total data information).

Clearly, the Tech Info bulletin rated highly with the client group. On a 5-point scale from low to high: 80 per cent rated its usefulness as a technological change resource as high; 87 per cent rated its quality of presentation as high; 75 per cent rated interest in content as high. Interest level, although rated highly, was rated less highly than the other two because some specific teacher groups (of bricklaying in building trades and wood machinists in furnishing trades), did not see the information as directly relevant to their trade areas.

The figure of 92.3 per cent wanting to receive future Tech Info bulletins strongly emphasised the degree of support by the teacher groups involved. Further supportive evidence was provided from the open section (4) of the questionnaire. Typical comments were: 'It fills the hole that is missing in the teaching of C & J'; 'Hope it's not a one-off publication'; 'Would welcome monthly abstracts'; 'Excellent, we need more of this'; 'Very good - should be more of it'; 'Good for other trades too'; 'There has been a need for this type of newsletter for a long time'; 'Greatly appreciated in Queensland and Western Australia'; 'Congratulations - this must be encouraged to continue'; 'Good for students too'.

Data on the resource materials used by trade teachers to obtain technological information supported the data obtained in the literature survey with respect to their preference for magazines, trade journals and pamphlets and visual materials. This was evident from the proportion of high ratings in response to questions 1.4, 1.5, 1.6 and 1.7:

Highest rating : trade brochures and pamphlets at 80 per cent
: technical magazines at 73 per cent
: technical abstracts at 54 per cent
Lowest rating : technical books at 35 per cent.

Responses to Question 3 indicated what trade teachers think are the most useful features of a technological change information service:

Highest rating : data such as tables, charts, graphs
: summaries of interviews
: abstracts with details of where to find information and original articles written by technical specialists
Lowest rating : summaries of journal articles.

(This question may have been misinterpreted by a few teachers in that they had difficulty in determining whether 1 or 5 was the rating to use for highest value. These ratings were arrived at by combining preferences 1 and 2, 4 and 5 and establishing the order for lowest and highest ratings.)

Clearly, there was a very strong preference for technical information to be analysed and presented in an abridged, visual form.

Question 2.2 sought information about the teachers' likely use of a 'phone in' computer service to obtain technological change information. Such a service was only supported by 51 per cent of respondents, with 33 per cent undecided. It would be interesting to know more about the reasons behind the uncertainty towards this service - whether it was due to concerns associated with using computers or uncertainties about the type and form of information that would be available.

The responses to the open question (4) provided much praise and support for the Tech Info bulletin, with 44 individual positive comments, six negative comments (mainly about

relevance) and 33 suggestions; some for improving the format and others suggesting follow-up video information about technology and the need for teachers to obtain hands-on experience.

2.6 Evaluation of the Tech Info newsletter for TAFE Authorities

The envisaged purpose of the newsletter for TAFE Authorities was to alert them to technological changes and possible implications for trade, technician and middle-level study areas with respect to planning, curriculum, staff development, facilities and resources.

After discussing the total concept of the scheme with Victorian TAFE officers, it was decided not to draw conclusions from the pilot study findings (the sample was not broad enough to be effective), but to inform TAFE Authorities of the total scheme and obtain their reactions to the wide range of services which could be available.

The Tech Info newsletter to TAFE Authorities was individually distributed by mail to TAFE directors, heads of curriculum, staff development, field services and policy and planning in Queensland, New South Wales, Tasmania, South Australia, Western Australia, Northern Territory and Canberra, 42 in total.

Only seven (16 per cent) responses were received (W.A. (2); Qld (1); S.A. (2); Tas (1); and N.S.W. (1). No significant conclusions could be drawn from these returns due to the small number, other than to indicate that all of those who replied were very supportive of the services and the potential of the total scheme (see Appendix E for total return data).

Although the Victorian TAFE Board officers were not included in the survey findings, they were in full support of the total project and appreciative of the services that it could offer.

2.7 Conclusions

The following conclusions derived from the process and product evaluation.

2.7.1 The information matrix appears to be a highly appropriate structure for developing an information system for monitoring technological change.

2.7.2 The monitoring role is very time consuming, though this may be reduced by experience gained in the trial.

2.7.3 Library back-up assistance per a central resource facility appears to be very important.

2.7.4 The sequence in which to search for information was the major learning outcome. The most effective process, both in time and use of resources, is to initiate from the across-trade classifications rather than beginning with particular trades, and sort the

resultant technological information into trade 'clusters'; and then, given these starting points, utilise the specialist monitors to seek further information from trade/industry/commerce related resources. The initial sorting role need not be carried out by specialist monitors.

2.7.5 The notion of clustering trade/industry/commerce areas is an important characteristic for sorting and reporting, but to be more effective, clusters need to have national nomenclature. Some mutual agreement between TAFE Authorities in all States could provide common clusters.

The clustering format is also reinforced from the literature survey and the evaluation of the Tech Info bulletin in that the information-seeking behaviour of the teacher group related highly to 'relevant' material. This suggests that brief, cluster-specific information bulletins are preferable to larger, wide ranging multi-area bulletins.

2.7.6 The project co-ordinator's function can be subsumed into the editorial group's role for any ongoing programs, since this group's role is central to all activities.

2.7.7 The Tech Info bulletin's quality, content and style appear to be highly acceptable and useful to the TAFE teacher reader group. However, in response to several suggestions made in the evaluation, future bulletins should be provided in a two-page or four-page format to facilitate filing.

2.7.8 The Tech Info newsletter for TAFE Authorities did not provide any clear results.

The following conclusions were drawn by addressing process and product issues to the literature survey (Chapter 4).

2.7.9 'Clustering' seems to provide an appropriate approach to technological change information processing, given that at the TAFE system level, especially, there is a growing trend to 'cluster' technologies together within broad occupational families, for example, transport, building, engineering, though it is admitted that in TAFE colleges there is still the tendency to narrowly associate technology and technological change with processes, materials, machinery or equipment of a particular trade or occupation (Section 4.1).

2.7.10 Focusing first on technological change data that crosses trade/industry/commerce boundaries - equipment, materials, processes, products, etc. - appears to provide an appropriate information-processing approach, given occupational trends, as technologies merge, for example, with the widespread introduction of microprocessors and lasers,

where the requisite knowledge and skills are similar whatever the job sector (Section 4.2).

2.7.11 There is an increasing urgency to find a suitable monitoring scheme, given the calls for TAFE to reduce the lead time for course review, staff development and equipment replacement, to have a proactive rather than reactive role in technological change, and to meet the many and sometimes conflicting demands of governments in implementing policies on, for example, youth programs, adult training, and 'high-tech' training (Section 4.3).

2.7.12 The information needs of TAFE Authorities seem clear enough, such as data that is relevant to policies, planning, co-ordinating, course development, equipment and facilities. However, there are formidable barriers to meeting these needs, such as non-communication (including lack of common nomenclature), uncertainty regarding basic education/training issues, absence of effective TAFE-industry relationships, divisions between the States and with Canberra, and lack of workforce planning in Australia (Section 4.4).

2.7.13 Evaluation of the Tech Info bulletin for TAFE teachers strongly confirms indications in the literature about teachers' perceived present information needs and information-seeking behaviour, such as their needs for up-to-date, directly relevant specialist technical data and their preference for printed information in précis or summary form, with graphics. There are also implicit demands being placed on TAFE teachers, especially trade teachers, to seek out and prepare new kinds of information to accommodate the 'new' TAFE student body (Section 4.5).

2.7.14 The literature provides various systems of monitoring, gathering, processing and disseminating technological change information that take on different emphases. Some of these are providing the raw data, setting-up monitoring schemes for TAFE system and teacher updating (based on using monitors), methodological approaches to data gathering and analyses, and ways of disseminating information. The processes and products described in this pilot monitoring project appear to accommodate most of the above points of particular stress (Section 4.6).

2.7.15 Accurate prediction or anticipation of technological changes that will occur in local industry appears to be feasible, provided a vast mass of Australian and overseas information is collected and analysed, including social, political, economic, legal and educational, as well as technological, data (Section 4.7).

3. RECOMMENDATIONS

The following recommendations directly derive from the pilot project's results. They also flow from:

- the persistent calls on TAFE to more effectively provide skills required by industrial and commercial fields which are becoming increasingly complex;
- growing demands for TAFE to complement government labour market policies in youth education and vocational training;
- the continuing strong impact of technological change on TAFE, raising powerful implications of information needs;
- the expressed need to provide TAFE teachers and Authorities with up-to-date technological change information in a form appropriate to their information-seeking behaviour.

3.1 That the monitoring process developed in the pilot project, incorporating the matrix model, be used for future monitoring technological change project phases.

3.2 That this project advance to the development phase, aimed at identifying information needs and methodologies for information collection from a full range of industry/commerce fields, data base arrangements for storing, retrieving and analysing information, and appropriate nationwide dissemination processes (including videotex).

3.3 That a monitoring unit be set up, including a permanent officer with co-ordinating and editorial control and casual specialist technical and library staff with monitoring roles.

3.4 That such a monitoring unit be appropriately supported, including resource funding, staff salaries, and production costs of bulletins and newsletters to enable it to at least provide a base service to TAFE teachers and Authorities nationwide.

3.5 That a central resource facility be appropriately supported to enable it to carry a fully-comprehensive technology/technological change information collection.

3.6 That a follow-up investigation carry out a detailed costing of the proposals in recommendations in 3.2 to 3.5. (N.B. cost estimates of a preliminary kind are shown in Appendix H.)

3.7 That a follow-up study, including cost benefits, be undertaken into the viability of a scheme providing fee-for-service assistance to TAFE Authorities and teachers, including a technical information, abstracting, alerting, product, equipment and instrument listing, and analysis service.

> It is vital to understand ... that technological innovation does not merely combine and re-combine machines and techniques. Important new machines do more than suggest novel solutions to social, philosophical, even personal problems. They alter man's total intellectual environment - the way he thinks and looks at the world.
>
> (Toffler, 1971, p. 29)

4.1 Some definitions of technology/technological change

Simple, limited definitions of technology continue to be relevant. The Macquarie Dictionary (1981) sees it as 'the branch of knowledge that deals with science and engineering, or its practice, as applied to industry' (p. 1775). The McGraw-Hill Encyclopedia of Science and Technology (1982) defines it as 'systematic knowledge and action, usually of industrial processes but applicable to any recurrent activity; it is closely related to science and engineering' (p. 502).

However, as Forbes (1971) observed, contemporary usage constantly pushes the definition of technology well beyond these limits. He cites usages such as those by Ellul: la technique is 'the ensemble of forces by which one uses available resources in order to achieve certain valued ends'; and White: technology embraces 'the systematic modification of the physical environment for human ends'; and Zvorikine: technology is the work within a social system of production including 'all the material conditions necessary to enable the production process to take place at all', and 'the means ... of human activity developing within a system of social production and social life' (pp. 8-9).

Then there is Forbes' own working definition: 'the mental or physical activity by which man alone, or together with his fellow-men, deliberately tries to change or manipulate his environment' (p. 9). And we can add the definition by Mesthene (1970): technology is tools in a general sense, 'including machines, but also including such intellectual tools as computer languages and contemporary analytic and mathematical techniques ... [technology is] the organisation of knowledge for the achievement of practical purposes' (p. 25).

Recent usage, notably at national and international government levels, has tended to associate technology with fields of science. One example is the list issued in the report by the Australian Science and Technology Council (1978). Here, the two concepts were merged to determine a classification system 'compatible with international practice, in that definitions of research and development,

and the classification system, are based on those adopted by the OECD' (p. 21). Hence the Council's classification for science and technology: 'Aeronautics and Aerospace; Agriculture; Atmospheric Sciences; Coastal and Ocean Engineering; Construction; Earth; Electronics; Energy; Environment; Food; Forestry; Fundamental Research; Health; Industrial Chemicals; International Relations, Liaison and Aid; Marine Sciences; Metal Products and Machinery; Mining Engineering and Mineral Processing; Organisation of Australian Science and Technology; Scientific and Technical Computing; Telecommunications; Textiles; Transport; Water Resources; Wood Products' (p. 21).

However, usage by the (Myers) Committee of Enquiry into Technological Change in Australia (1980) afforded technology associations beyond the fields of science. The Committee drew attention to aspects such as economic, employment and social issues and legal or quasi-legal matters relevant to industry and government; whether technology is entirely related to equipment or whether managerial and marketing skills are included; whether a technology is new only when it is first applied or is considered as new each time it is applied on a further enterprise.

The outcome, was a definition adopted by the Myers Committee which was, in effect, mainly restricted to processes, products and equipment, precluding analysis of the development and effects of social and other changes:

> Technology is the body of information and of skills and experience developed for the production and use of goods and services. It may include:
>
> - scientific and technical knowledge related to particular products, processes and methods of production;
> - engineering knowledge required to design, develop, implement, produce, operate, install, service, maintain or adapt machinery;
> - managerial knowledge required to marshal a work force, operate plant and equipment, obtain and administer funds, and identify, establish and satisfy markets. (p. 8)

And its definition of technological change was:

> Technological change is change in processes, materials, machinery or equipment, which has impact on the way work is performed in an enterprise or on the efficiency and effectiveness of the enterprise. (p. 8)

The Australian Science and Technology Council in its report on technological change and employment (1983) noted criticisms of the Myers Committee definition and offered its own (one that was not limited to an association with science or hardware):

> Technological change is change which leads to new products (including services) or to new processes for producing existing products; technological change involves an impact on the nature of work (mediated through techniques of organisation and management), on the economy, and on society. (p. 27)

In TAFE, usage of the word technology has tended to accord with the Myers Committee's definition, being strictly associated with the body of knowledge of a particular trade or industry and the application of such knowledge. TAFE occupational subjects are typically identified by the technology they embrace, for example, refrigeration technology, machine tool technology, eletronics technology, building technology, concrete technology and aircraft technology. So, too, usage of the term technological change is understood as referring to a change in processes, materials, machinery or equipment in a particular industrial or occupational field. However, at the TAFE system level, especially, we note an increasing tendency to 'cluster' technologies together, for example, transport, building, engineering, within broad occupational families.

4.2 Industry's adoption - anticipating skill requirements

One body of opinion argues that significantly higher technological skills will be required right across Australian industry in the future. For example, in terms of skill requirements, the Myers Committee on Technological Change (1980) indicated that the likely new technologies would require, on average throughout the country, higher skills performance than the present technologies used in industry currently require. It identified the following technologies as being particularly important for industry: microelectronics and micro-processors, information technology, genetic engineering, robotics, alternative energy sources, and new materials.

Against this, are the opinions of people such as Cooley (1980) in the United Kingdom, who has strongly drawn attention to the phenomenon of 'deskilling' in the human-technology relationship, and Reinecke (1982) in Australia, who has pointed to vastly reduced skills levels especially in middle-range occupations. We may extrapolate his observations regarding telecommunications: how technological change concentrates skills at either end of the job spectrum, 'taking out the middle'; the technology demanding either very skilled electronics engineers or those with straight physical skills needed for functions such as lifting, carrying and simple installation (pp. 52-3).

Another perspective is provided by Pankhurst (1983) who has observed, based on OECD experience, that there seems to be a convergence toward the middle between persons with professional qualifications and traditional skilled labour, that the gap is filling up as new sub-professional and technical jobs increase in numbers. So some countries are talking about emerging 'middle-level' skills. He gives examples of the evolving character of work at this level:

- the combining of skills from different trades as technologies merge, for example, ceramics and metal working, plumbing and electrical work in heating and cooling systems, and electronics and technical drawing;
- the combining of technical and managerial skills by technicians, who now have to solve complex problems that require the ability to recognise them, to refer the relevant theory and to devise and apply a solution;
- the transforming of existing skills within the existing occupational titles and the setting-up of a series of consequences in other jobs that cannot be readily anticipated.

A most comprehensive analysis is in the Australian Science and Technology Council (1983) report on technological change and employment. Major features of technology-induced changes in the nature of work are elaborated, including:

- the elimination of many unskilled jobs and a transition from experience-based technologies to science-based ones; for example, in manufacturing industry the tasks of the production worker have shifted emphasis to instrument monitoring and maintenance;
- a trend towards the homogenisation of work; for example, with the widespread introduction of micro-electronics, repair and maintenance functions are similar whatever the industry;
- the increasing polarisation of skill levels - to an increasing degree the more highly skilled people are involved in management functions, and others in relatively narrow areas of activity that may have been deskilled.

As well as these qualitative aspects, anticipating skills requirements needs addressing in growth sectors of employment, both within industry and outside industry, given the broad definition of employment suggested in Jones' (1982) list of most likely areas for future work expansion (not all of them desirable, he notes):

1. education, including recurrent education and training for the semi-skilled and unskilled;

2. home-based employment, including domestic work, maintenance and gardening on a contract basis, home security;

3. leisure, tourism, sport and gambling;

4. dining out;

5. provision of drink, drugs and commercial sex (and treating their adverse effects);

6. craftwork, the arts and entertainment generally;

7. individualized social, welfare and counselling services (especially geriatric or psychiatric);

8. individualized transport systems, e.g. taxis, personal drivers, fixed-route minibuses (such as the pereros of Mexico), courier services, point-to-point delivery;

9. public-sector employment administration, armed forces, police;

10. hobby-related work, including DIY work in the informal economy, antiques and collecting;

11. small-unit energy generation (solar, wind, and growing crops for "biomass"), and subsistence farming;

12. manufacture of leisure and solar energy equipment: (boats, games, solar heaters and collectors);

13. materials re-cycling;

14. recognising that some existing forms of work are essentially "welfare industries" where the main output is employment;

15. nature-related work, including gardening in the widest sense; the care and preservation of wildernesses, forests, deserts and natural parks, coastlines, the development and care of footpath networks;

16. care of animals including selling, breeding and grooming pets. (p. 240)

Also there are the important high technologies relevant to Jones' notion of 'sunrise industries', including personal computers, lasers, industrial ceramics, biotechnics, solar energy cells, fusion, robots and software writing.

The view of the Kirby Report (1985) is that there is no real consensus about the impact of future structural and technological change, making it impossible to anticipate at all precisely the future content of jobs and related human resource (skills) requirements. It urges a more careful examination of the relationships between technology and the organisation of work, in the interests of finding the skills that individuals can bring to, and develop at, the workplace.

3 Implications for TAFE

Voices from both outside and inside TAFE are continually raised about the impact of technological change on the system, especially implications concerning recurrent education.

Arguments can be traced back to Kangan (1974) who proposed that TAFE's revitalisation and extension should assume a social objective of recurrent education.

Ford (1979) argued that TAFE would need to develop its own continual learning systems to enable it to cope with its own changing environment, if recurrent education were to provide a basis by which individuals and groups could cope with continuous multi-dimensional change.

More recently, Smith (1983) contended that technological change powerfully reinforces the reasons for recurrent education: the need for most people to update, upgrade and change skills during their working life makes the 'front end model' less appropriate than ever (p. 265). (The 'front end model' confines education to a limited period in life.)

However, a major problem raised is that of the TAFE system responding fast enough to change.

Swain and Cappo (1980) observed that important technological changes now occur at shorter time intervals than the time required by current TAFE systems for course revision, staff retraining and equipment replacement. (On the 1980 reckoning in South Australia, to keep abreast of technological change, 14 per cent of staff members would need to be retrained each year and an additional $1.6 million would be required annually for new equipment.)

Regarding TAFE's involvement in trade education, Rumsey (1984) observed, traditionally we have been locked into a four year apprenticeship mode embracing three years' schooling, yet the four years' apprenticeship is longer than the typical industrial cycle of ups and downs.

Also, there is the issue of staff retraining. The study by Henderson and Warnock (1982) on technological updating/retraining needs of TAFE personnel in Western

Australia, showed disturbing results, concluding that there was apparent non-participation by a large proportion of senior staff, heads of department, etc. in staff develoment within their specialist area. For example, the majority in Electrical Fitting and Installing, Commercial Studies, Cabinet Making and Building and Architectural Drafting had not undertaken updating for periods frequently in excess of 10 years.

Others argue that TAFE needs to do more than merely be reactive to change. For example, there are novel arguments by people such as Grosvenor (1983) who extended the discussion raised by Swain and Cappo. He proposed that TAFE should be seen to have a proactive role in technological change, rather than, just a reactive one. Of the instruments of the State government, TAFE was, he argued, one of the most strategically placed to influence the direction and effect of technological change. This was because of its being an important user, developer and selective promoter of, as well as trainer and educator in, the technologies.

Remarks by Crudden (1980) are also relevant: that TAFE was, itself, subject to the impact of rapid societal change and the introduction of new technology. It was, itself, a socio-technical system subject to strong social, political and economic pressures. It had, though, the capacity to be proactive in its social as well as technical provisions, providing it developed a new corporate ethos.

Then there are arguments by Kennedy (1983) who proposed a direct role for TAFE in the transfer of technology and the adaptation to consequent structural changes in Australian industry. He argued the need to predict and choose those industries which would guarantee most wealth; ones that would be likely to assist most, directly and indirectly, in economic and employment generation. No doubt, this proactive function would be subject to TAFE's capacity to collect the 'right' technological change information (and, of course, it is the main object of this project to assist this).

Also, and most important, technological change implications for TAFE are to be seen in the light of the Commonwealth Government's youth labour market, education and training policies that have been recently documented in the following four sources.

The Commonwealth Tertiary Education Commission's report, Learning and Earning (1982), identified some of the linkages between education and work, including: the rapid growth since the late 1960s in the educational attainment level of the Australian labour force; the continuing strong and positive relationship between educational achievement and employment; the concentration of low achievers in the least attractive post-school destinations - low skill jobs, long-term unemployment, or total withdrawal from the workforce and education; competition by academically able teenagers for jobs that were previously filled by the less academically able; and the incentive given to young poeple to leave education that seems to stem from shortcomings in the labour market situation.

The Participation and Equity (1983) document proposed the long term objective that by the end of the 1980s most young people would complete the equivalent of a full secondary education, either in school or in TAFE, or in some combination of work and education. The TAFE colleges' role was seen as that of catering for the education and training needs of 15 to 24 year olds, particularly 15 to 19 year olds.

The OECD, Review of Youth Policies in Australia (1984), identified six deficiencies under the current arrangements:

> (i) Females are underserved and channeled into education and training paths to lower-paying, lower-status jobs;
>
> (ii) Secondary school retention is too low;
>
> (iii) The quality of TAFE training is not clearly documented, its relevance is not assured, and its capacity for expansion is uncertain;
>
> (iv) Apprenticeship training is in danger of becoming obsolete and is too vulnerable to short-term fluctuations in economic activity;
>
> (v) Enterprise-based training is too much of an unknown and uncontrollable factor;
>
> (vi) Access to higher education is biased against females and disadvantaged young people. (pp. 92-3)

Hence, its main conclusion: 'The highest priority for the Australian youth agenda should be to raise educational attainment, increase broad-based occupational skills, and assure that education and training opportunities are accessible without regard to sex or socioeconomic status' (p. iii).

Last, the Kirby Report (1985) proposed a comprehensive education and training program incorporating: a new traineeship scheme for 16-17 year olds (part-time employment plus part-time off-the-job training, mainly in TAFE colleges); improved trade training (including extending preparatory training through trade-based pre-employment programs, with preference for a 'family of occupations' approach); double funding of adult training and retraining; equal participation by women and men in all labour market programs; rationalisation of wage subsidy arrangements; special aid for people in remote areas, unemployed migrants and disabled people; a new Australian Youth Service incorporating existing support schemes; and a new umbrella advisory and administrative body, a National Council for Training and Employment.

4.4 Information needs of TAFE Authorities

The relevant information needs of TAFE Authorities are suggested in External Information Needed by TAFE (1984) which reported on a national conference on educational planning and associated information requirements. Papers that were read followed guidelines which addressed such aspects as:

- policies and procedures for educational planning at central, regional and local levels;
- organisational structure for planning;
- extent of integration of educational planning;
- co-ordination of planning;
- the extent to which adequate information is available for planning, and any further information required from external sources;
- application of information for planning purposes;
- communication between local and State planners with respect to issues and priorities. (p. 4)

Pulsford's (1984) discussion paper, that presents a 'within TAFE Authority' model for collecting technological change information, lists requirements including:

- specialist requirements (compare the needs of curriculum developers with those of persons concerned with staffing and equipment);
- curriculum development and monitoring requirements ('most urgent need is to keep up with actual local developments');
- production and policy development, impinging on questions such as:
  - Should TAFE anticipate future occupational boundaries and base its response on modifying existing occupational courses?
  - Will courses for new groups of skills need to be developed? If so, what courses?

- Should short courses be developed to handle specific new groups of skills?
- Should course access requirements be modified?
- What strategies will be needed to teach teachers the new skills and theory?
- Will new staff be required? (p. 14)

By implication, Crudden (1980) identified TAFE Authorities' information needs in discussing broad issues requiring an assertive TAFE planning approach for assisting it:

- to specify the role of technology in facilitating the participative planning policy espoused by TAFE;
- to train personnel who will enable the system to receive, process and diffuse information about the rate and direction of technologicl change and its social impact;
- to develop structures and processes to support the devolution of effective decision making;
- to pinpoint areas for co-operation with other educational sectors, including training within industry;
- to cultivate awareness in TAFE personnel of the impact of technology on its policy, planning strategies and services, and to raise general political consciousness within TAFE. (p. 4)

Such are some of the information needs of TAFE Authorities. However, Duke and Sommerland (1983), in their study of trade training in the electrical and automotive trades, cited several barriers to meeting those needs. These include:

- non-communication (the use of the same terms to mean different things - or different terms to mean the same things -) and negative stereotypes held by different parties (especially TAFE personnel and industry);

- lack of categorisation of needs (for example, in distinguishing 'renewal'/'refresher'/'upgrading' and 'retraining' requirements);
- variations between one State TAFE system and another and the rapid evolutionary state of the systems;
- widely differing views about the role of TAFE (TAFE top co-ordinators had not had time to develop 'philosophical clarity' (p. 310); differences existed over how much general education/instructional training);
- TAFE organisational features that militate against its having an effective relationship with industry (TAFE is often castigated as being too rigid, slow and traditional);
- the Federal system (division of responsibilities between Canberra and the States;
- sectoralisation or polarisation of Australian society between conflicting interests (militating against long-term planning).

Also, regarding trade education, Rumsey (1984) in his paper implies a variety of organisational issues that raise doubts about productive information dissemination. These include:

- uncertainties about the apprenticeship system (in 1983, apprenticeship intakes declined by about 40 per cent in New South Wales);
- the virtual non-existence of workforce planning in Australia. As Rumsey puts it: 'Whether it can be done well, given a dynamic environment, is another issue. Perhaps we are only deluding ourselves if we think we can be that specific' (p. 71).
- (as cited elsewhere) the traditional 'locking-in' into a four year apprenticeship which is longer than the typical industry cycle of ups and downs;
- guaranteed industrial acceptance of alternative structures (with implications for whether or not one looks for alternatives);
- recognition by providing authorities of the actual costs that might be incurred in trade education programs.

4.5 Information needs of TAFE teachers

Considerations about TAFE teachers' information needs are usually in terms of library resources provision. Interest can be traced to Fleming (1978) who proposed a research project aimed at identifying print and non-print resource materials relevant to TAFE teacher preparation (and, we can infer, staff development).

Such a project was carried out by the (then) State College of Victoria at Hawthorn, which produced a master subject and title file of library holdings of participating colleges, and other lists of potentially relevant material from British and American sources.

Further, Coughlan (1979), recommended that colleges co-operate in purchasing/producing relevant materials (the research project forming a starting point); also that money be allocated for developing work on the acquisition, appraisal and dissemination of Australian and overseas information - an appropriate activity 'for the national centre for research and development in TAFE...' (p. 14)

What must be known, though, are TAFE teachers' own perceived information needs and their degree of library usage.

Eckersall's (1983) study of the information needs and information-seeking behaviour of 1,665 (EFT) initial and post-initial course students at Hawthorn Institute of Education reported:

- they have diverse information needs, reflecting their considerable individual differences in respect of level of previous education, industrial/academic development;

- they have diverse information needs in respect of their professional/specialist/personal development,

- they especially need an up-to-date representative collection (print and audio-visual) that is relevant to their specialist/technical field:

- they have special information needs, reflecting external developments such as technological change, new government youth policies, educational changes - use of alternative teaching methods, self pacing, resource-based learning, etc.;

- they predominantly use information sources that are most convenient and readily available, and provide direct access to others' experience - per interactive processes. [Sheppard's (1980) study of the information needs and information-seeking behaviour of 78 trainee TAFE trade teachers drew the same general conclusion];

- they mainly prefer to receive information per interpersonal sources - other teachers, head of department, teachers' college lecturers - then from printed resources. [This confirms known adult learning patterns: for example, Tough (1979) has suggested a widening circle concept where adults tend to seek information first from informed intimates such as fellow-learners, then from experts - a group leader-instructor, and then from non-human resources such as books and magazines from a library];

- they prefer printed information sources that provide directly relevant information - hence the importance attached by trade teachers in building studies and plumbing and sheetmetal to industry literature and government information - codes, regulations, etc.; also other trade teachers particularly value technical magazines, for example electrical/electronics, hairdressing;

- they prefer to receive information in summary form;

- they prefer to receive information per well-produced and up-to-date audio-visual media, especially video-taped programs;

- their information usage is mainly limited to conventional formats (books, magazines, pamphlets, audio-visual), reflecting a lack of experience or dissatisfaction with alternative formats, for example, abstracting service, telephone enquiry service, microfiche facility, computer facility.

Further light is shed by Gullan's (1978) study of the staff profile (72 teachers) at a large metropolitan TAFE college (Swinburne), which reported: teachers of apprentices do not make high use of the library, even though they may have no complaints about the sufficiency of stocks or appropriateness of service; and teachers in tertiary orientation and middle level programs have high usage, even though they have many complaints.

A further question is one of variations in TAFE teachers' information needs that arise because of variations to course requirements.

Differences in information needs are implied by Schilling (1983) who distinguished four approaches to trade education, regarding content and method:

- general skills - content would consist of learning to perform many of the 'basic' skills of trade occupations in general and some of the basic skills of a specific trade ('Trade A'), plus the theory underlying the practices; teaching method would emphasise principles of learning to learn and of transfer;

- common skills - content would consist of some of the basic skills of a small number of trades, plus a specified number of specific skills from 'Trade A'; teaching method would emphasise the transfer of skills across trades, for example, the transfer of a skill in 'Trade A' to the application of this same skill in 'Trade B';

- specific skills - content would consist of specific skills from 'Trade A'; teaching method would emphasise the attainment of a high level of competence in the specified skills and the transfer of skills within

'Trade A', for example, the transfer of "Skill 1" with one machine to a newer updated machine.

Further information variations are suggested in Schilling's proposals regarding the following four groups of courses:

- pre-vocational (explanatory career awareness courses) - 1. secondary school pre-vocational courses; 2. 'general' transition (that is, non-occupational);

- occupational (directly related to an occupation or a group of occupations) - 3. pre-employment trade (includes pre-apprenticeship and multi-trade); 4. part-time trade.

So, depending upon the approach to content and method, and the course category, the TAFE trade teachers' information requirements vary.

Papers gathered by Sandery (1984), presenting differences between the States and conflicting personal and group opinions regarding trade education futures, also suggest wide information variations. For example, Phelan, a Queensland industrialist, postulates that trade education will include two levels of development: the continuation of traditional apprenticeships and pre-vocational entry into trade training; Mill, an apprentice training official from South Australia, suggests that in importance and likely future usage the ordering will be 1. pre-vocational, 2. pre-apprenticeship and 3. traditional, while Noonan, Secretary of the TAFE Teachers' Association, proposes a future path using the traditional trade course model with a work study combination, including a first year of institution-based training.

Finally, we address questions about TAFE teacher technological change information needs in the light of recent observations about a 'new' TAFE student body.

The study on issues in access by Hawke and Sweet (1983) drew attention to trends in new access provisions in the 1970s which resulted in changes in the nature of the TAFE student body, where there has been a significant departure from the traditional mode of TAFE operation, that is, the college-based teaching of vocational skills to capable, motivated, part-time students, most typically male, with concurrent relevant employment. Hawke and Sweet suggest that a significant number of TAFE teachers are, as a consequence of changes, being asked to assume roles for which neither their initial training nor their experience has prepared them. 'Teachers, particulary in the trades, because of their previous habit of teaching vocational skills to the committed with relevant concurrent employment are ill-equipped with the pedagogical skills and teaching materials required to illuminate, simplify, place in context, and make their subject intrinsically interesting.' (p. 16)

In like manner, Neal (1984) raised issues that suggest new information needs and flexible teaching approaches, in remarking:

> Some of TAFE's clientele are considerably different from those to which TAFE teaching staff have been accustomed. One notable difference concerns the characteristics of students who are in their late teens or early twenties, and who come to classes with low level skills and with little motivation other than to fill in time, hoping to become more qualified for employment... Typically, TAFE teaching has been tightly structured and the kind of flexibility that might be necessary to deal with such students is not readily acquired. (p. 84)

1.6 Systems for providing, monitoring and processing information

Some of the literature deals with approaches to providing technological update for vocational teachers, such as the report by Wonacott and Hamilton (1983), which outlined programs including: work experience internships; university and college course work; workshops, conferences and seminars; industry observation; education and industry staff exchange; and part-time employment. Also, they noted major barriers, including limited funding, lack of individual and institutional motivation and policy shortcomings regarding teachers' responsibilities to keep up-to-date. In a follow-up report (1984), on a strategy for action, they proposed a plan designed to meet nine criteria; such a strategy should provide an organisation or structure for action; define involved individuals' roles and responsibilities; present policy statements to support the roles and responsibilities of those involved; define and provide necessary resources; provide incentives and rewards to achieve and maintain motivation; identify and provide a variety of techniques by which teachers can gain technological updating; allow for and provide alternative and creative 'configurations' of techniques to best meet individual needs; provide for the incorporation of knowledge and skills gained in update activities into the course program; and provide for continuing and self-renewing activities to maintain technological updating.

Other literature deals with models for monitoring, collecting and processing technological change information used for teacher updating.

The paper by Pulsford (1984), proposing a 'within-TAFE Authority' model, outlined an information collection plan based on setting up a monitoring unit to 'co-ordinate all the Authority's requirements for information on new technologies'. (p. vii)

The model details two working groups:

(i) co-ordinators, constituting a Technological Change Unit, responsible for monitoring the Authority's overall response to technological change and providing information necessary to the management of that response; their functions to include -

- overall responsibility for co-ordinating information collection and dissemination;
- developing the argument of "mutual advantage" (i.e. that TAFE's knowledge of industry developments will benefit both industry and TAFE);
- ensuring that each monitor's network is operating satisfactorily;
- refining of techniques for each of the monitors;
- receiving data from the monitors;
- identifying destinations for data from the monitors;
- developing techniques for collating and disseminating data from the monitors;
- developing a perspective on "major changes" and the implications of accumulated technological changes, and investigating the policy implications;
- developing a perspective on technological change across industries and, in particular, identifying the specific technologies which are most prone to moving across industry and occupational boundaries;
- alerting monitors of changes likely to be affecting their occupational area;

- anticipating (predicting) likely changes by:

  - monitoring firms' commitments (managers);

  - monitoring advice being given on future commitments (e.g. from engineers, consultants and salespeople);

  - monitoring research and development (local research and development, literature, professional researchers);

  - instituting evaluative measures or feedback systems to ensure relevant information is reaching its destinations satisfactorily;

  - monitoring literature relating to the "state of the art" and research and development, especially from overseas countries;

  - assessing technically feasible developments with respect to local economic, political, social, and industrial relations factors (pp. 23-4);

and

(ii) monitors - technical specialists - responsible for monitoring technological change within specific occupations or groups of occupations; their functions to include setting up a monitoring network to gather information

- from industry contacts;
- per industrial visits;
- per committee/brainstorm approaches;
- from visiting exhibitions;
- per liaison with industry and government groups;
- from literature

and passing the information on to the co-ordinators for processing.

Pulsford claimed the following benefits of the model:

- comprehensiveness - specific methodologies can be selected according to circumstances; the model allows for analysis of the full range of technological change problems - data gathering, equipment/staffing/resource issues, management styles, teaching methods, etc.;
- integration - it proposes that technological change issues be handled in an integrated way, to lessen the possibility of complicating solutions being applied, and to assist the rational distribution of resources;
- focus - it proposes that all technological change information pertinent to an Authority response flows through a single focal point;
- responsibility - it proposes that the focus of information constitute a unit with continual responsibility for analysing the impact of technological change and for proposing action;
- continuity - it proposes a dynamic, continual approach rather than a static or piecemeal one; this approach is applied to monitoring, predicting, curriculum development and implementation and policy development;
- flexibility - it is designed to allow for implementation both across the range of authority systems and within the Authority of which it is a part;
- analyses and dissemination - it assigns responsibility to one unit for the entire information exchange process;
- evaluation - it allows for continual evaluation of the impact of technological change on the Authority, the Authority's response to technological change and the functioning of the model itself;
- self improvement - it allows for continual improvement and adaptation;
- minimal resource impact - estimates are that it would involve one-two people to perform functions of the Technological Change Unit, and half a day per week for monitoring each of the occupational fields;
- minimal structural impact - it anticipates that in most systems implementation could be achieved with only minor re-assignment of duties;
- low level continuous model - it proposes low level continuous activity and emphasises setting up communication links which make the best use of available information;

- separation of functions - it separates those functions which require methodological sophistication and sensitivity to policy development processes from the monitoring tasks which require appropriate industry background and a knowledge of curriculum development requirements;

- trigger devices - it provides a 'triggering' process so that urgent investigations may be initiated at the earliest moment;

- early warning - it provides for the monitoring of technologies transferred to one industry field from another, alerting monitors of the types of developments which may occur and briefing them of the likely significance of these kinds of changes when they do occur.

A thesis by Evans (1983), that critically reviewed systems for monitoring technological change in TAFE in New South Wales, Victoria, South Australia, Western Australia, Northern Territory and Tasmania, and some vocational agencies in the United Kingdom, Unites States and Sweden, also proposed the designation of monitors within a model incorporating:

- the appointment of technological change officers for particular study areas whose duties would include liaising with the Director (Curriculum), the head of schools and the TAFE National Centre for Research and Development, co-ordinating advice from course advisory committees, receiving and disseminating information relevant to their study areas from Australian government bodies and overseas vocational agencies and from teachers who have participated in industry seminars, exhibitions, project fellowships and research projects;

- the national co-ordination of TAFE research and curriculum development instead of the States independently using Commonwealth funds for their own course development;

- better use of course advisory committees for reporting technological change as it diffuses into local industry; these committees would channel proposals for major course reviews to the Commonwealth for funding, and the TAFE National Centre would co-ordinate the main research for the reviews;

- better use of information sources such as the Technology Transfer Council, the CSIRO, industry groups;

- improvement of the project fellowships scheme by making awards to project teams rather than individual investigators.

The draft paper by Davis (1984), that deals with information needed by TAFE for planning and management, suggested a plan incorporating a Part 1 and Part 2 model.

Part 1 describes a model that could be used to demonstrate the relationship between the data to be collected and the relationships and purposes that TAFE might have within and extraneous to itself. Hence, it deals with the varieties of audience that could use data for planning and management purposes, apart from TAFE head office, including TAFE personnel, TAFE colleges, teacher training colleges, industry groups and government departments.

Part 2 proposes a procedural model that is a modified version of one from the National Center for Research in Vocational Education at the Ohio State University.

It lays down (i) - sequentially - six procedural questions to be asked in collecting data:

1. Where are we going? (determination of priorities, which particular TAFE purposes are being pursued, and to what extent?)

2. How do we set our goals? (are we going to measure our achievements in absolute or comparative and relative terms; if the latter, what yardsticks are chosen?)

3. Where are we? (description of actual situation; and qualitative measures of actual inputs, outputs and process of system as compared with achievement levels wanted)

4. How (and when) will we get there? (setting of ultimate and intermediate target goals for achieving purposes, can be a prescriptive exercise or an 'indicative' one)

5. What resources do we have? (what on quantitive and qualitive measures are current levels of physical and human resources to achieve the stated goals?)

6. What adjustments do we need to make? (what adjustments to inputs and processes are needed - in quantitative and qualitative terms - to move actual results closer to desired ones?)

And (ii) it suggests five methodological questions under the heading 'how do we find the answers'?

1. How specific do we need to be? (do we need to collect data at national, State or regional levels; from the general population or special groups; how specific should be any industrial or occupational classifications; at what levels of specificity will ambiguity in data disappear, how much ambiguity can be tolerated?)

2. What data already exist? (what are best procedures for identifying and assessing existing data; how specific are they to the purposes required?)

3. What do we need to add? (where are the gaps in data, how should their collection be attempted?)

4. What is the privacy and equity consideration? (how are rights of community groups and individuals affected by data

collection (N.B. importance of question for industry); are privacy and equity violations being anticipated and adequately avoided?)

5. What will be the costs? (how does cost affect the choice of data collections available; given selection of threshold level and type of data collection adequate for comprehensive policy and management, has an attempt been made to minimise costs?)

Some models stress sophisticated collection and analysis techniques. For example, a case study by Billings et al. (1977) illustrates a model which used a quasi-experimental time-series analysis of structured interview data for measuring the impact of change in technology on job characteristics. The technological change mainly affected the assembly and delivery of meals to patients in a large United States metropolitan hospital. It centred on the replacement of steam tables by a 50 foot-long conveyor belt, operations most affected being rigidity of work flow and extent of automation, both of which increased. The research design called for multiple measures over time, with four waves of interviews, two before the change and two after. Items were constructed to measure job characteristics, including job importance, task variety, task interdependence, required task effort, mobility, time pressure and feedback from the work. Regression was used to compare the pattern of data before and after the treatment - the change in technology.

Other models emphasise the importance of validation. For example, Goetsch (1982) describes an approach in the United States to keep course content up-to-date as follows. Traditional methods of information gathering were employed: craft or advisory committee input, visiting the workplace and reading technical journals. A technique borrowed from textbook publishing was used to validate the content - potential employers of students graduating from the industrial program were asked to rate each topic as deserving of in-depth, moderate, light or no treatment.

Finally, there is the matter of information processing and dissemination, and the possibilities of using telematics, including the telephone, radio and television broadcasts, recorded audio and video and, particularly, computers, videotex and satellites.

A paper by Gould (1985) argues for using telematics - and, specifically, computers - as a means of delivering TAFE education and training, one argument being that the rapid changes in the nature of work necessitates people updating their skills more often than in previous times.

Among others, Porter (1984) has proposed some possible educational uses of Australia's first domestic communications satellite, including TAFE extending its network to bring short non-award programs and long-term award courses to its clients. Satellite technology will quickly enhance student (and TAFE teacher) access to technological change (and other) information in central data exchanges.

An argument for a coherent data base arrangement is implied in a report by Stubbs (1983) on data base systems for meeting the planning and management information needs of TAFE Authorities and institutions. It concluded that existing ones are inadequate, mainly because of the ad hoc development of computerised systems in each State. Hence, its major recommendation for a long-term strategy plan, covering a time frame of at least three to five years, for the development, implementation and operation of information systems.

4.7 Prediction issues

In his discussion paper, Pulsford (1984) uses 'prediction' and 'anticipation' interchangeably to refer to collecting data on technological changes which have not yet been implemented in local industry. He asserts it is possible to see major technological trends in advance, emphasising the importance of predictive data in TAFE policy planning. Collecting technological change information for TAFE requires 'monitoring changes as they occur in industry, as well as anticipating the changes which are likely to occur' (p. vii). Though, he further suggests, for TAFE, rather than considering technological data to tackle prediction, it seems more efficient to use management data, addressing technological feasibility, economic feasibility, acceptability to governments, industrial acceptability and attractiveness to management.

Prediction issues were raised by Bell (1974) who distinguished 'forecasting' from 'prediction'. ('Forecasting differs from prediction' (p. 3.)) He argued that we can make meaningful forecasts about the future of modern society (including its technological future) if we take the trouble to understand fully the society's present condition and the trends visibly at work in it. Forecasting is not prediction: we can perceive the limits within which the shape of things to come will be defined, but the definition itself will depend on our 'political creativity', and, obviously, that creativity will be more or less fruitful as it takes into reasonable account the limits within which it will have to operate.

So, technological change forecasting calls for the development of a futures-oriented data base that will provide information about the past, present and future. The technological change should not be seen apart from, but interacting with, the overall change context, encompassing social, political, economic, legal and educational factors.

According to Nelson (1980), who discussed new and emerging occupations in the United States, and a process for monitoring and identifying the impacts for vocational and technical education, techniques developed for studying the future, such as scenario and Delphi, can be employed. Technological change is not to be considered in isolation from other change agents. Five groups of interconnected change factors are linked for consideration:
1. Technological change, 2. Demographic change,
3. Legislation, 4. Life style changes, 5. Resource changes. These changes and trends need to be analysed to

determine the implications for new occupations. Also, continuous monitoring and analysis of changes in these five sectors will keep vocational and technical educators at the 'cutting edge' of new technology.

Prediction (or anticipation) in technical and vocational education is, therefore, to be addressed in the broad external context. To further illustrate the point, a case study of Adams and Mecca (1979) reported on 'future events impacting occupational education' in central New York. It outlines a first phase which utilised the Delphi technique to generate a series of statements describing probable future events that were seen as having possible impact on occupation. Statements were elicited from a panel of individuals who, while not part of the occupational education system, had a knowledge of various types of future events, including technological, economic, demographic and political. The second phase, the substance of the report, used the statements of future events derived from the first phase to generate a series of alternative futures ('future casting') from which policy implications for vocational education could be determined. As well as technological changes, other influential factors were seen to be labour force trends, social and personal attitudes and values, educational policy and practice, demographic changes, ecology, and public and social policy.

T E infoC H
TECHNOLOGICAL CHANGE INFORMATION FOR TAFE TEACHERS
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LASER LEVELLING IN THE CONSTRUCTION INDUSTRY

Use of laser levels in the construction industry is in:

(a) building structures and multi storeyed buildings;

(b) civil earthworks and machine control;

(c) drainage and water flow such as sewerage, storm water, etc.;

(d) tunnelling.

BUILDINGS

The first laser level used in the construction of buildings was in 1968. The level required manual adjustment with a power output sometimes greater than 5 milli watts. These instruments gave 20 second accuracy in the glass level vials. The lasers used a helium-neon gas medium incorporating a side arm tube. These levels were used mainly for suspended ceilings, fire protection installations and direct work, concrete formwork and partitions.

In 1976, automatic self levelling features were built into the housing of the laser level. These devices incorporated an electrolytic level sensor. In these, a tilt determines the welted length of electrode in electrolytic fluid and the resistance unbalance serves as an error signal in a closed loop circuit which drives the optical chassis of the level.

Also in 1976, parallel coaxial laser tubes were developed which significantly reduced the size of the units.

With the introduction of automatic self levelling devices, the operation of the laser level transferred from the professional operator to the "layman", this being significant in regards to several aspects of technological change.

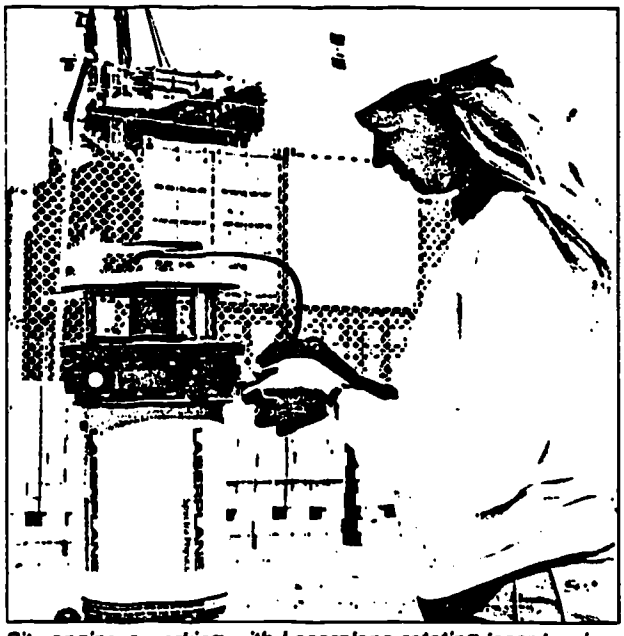
Laser eye detectors were then developed to give the unit greater range, and because the beam did not have to be viewed physically the range of applications increased.

In 1980, infra-red laser levels were developed which incorporated a solid state laser diode instead of a helium-neon gas laser tube. Currently, all laser levels are heading toward the infra-red type except those used for drainage where the visible beam of the helium-neon laser is still essential.

The two basic types of laser levels used in building are the rotating type and the stationary beam-alignment type.

The rotating laser can be used for various horizontal control applications such as subgrade preparation, excavations, positioning formwork, computer floors, suspended ceilings, duct work, water services, fittings and fixtures, concrete placement and various setting-out applications. They can also be used in a vertical plane application for setting out walls, partitions and other structures. Many levels also feature vertical plumbing capacity and right angle setout features.

Laser detectors are all basically of the same construction, using photo-electric cells, but they vary in styles. They give indication by light, sound or by a tape moving on a staff which measures, sets and then gives an audio or light signal to indicate the elevation of the beam.



Site engineer working with Laserplane rotating laser level.

The rotating laser level has also an automatic, self-aligning grade setting capacity which is used mainly in machine control applications. There are no infra-red laser levels with grade setting features; however, this development is expected in 1985.

CIVIL MACHINE CONTROL

Rotating helium-neon lasers are the basic units used in civil machinery control. The lasers are basically the same as those used in building applications except the beam diameter is generally double the building laser beam diameter. The range is 300 m rather than 150 m. Technology has recently automated laser tube manufacturing and now hard-seal/long life tubes are produced. Projected developments include infra-red laser diodes. The receivers and control boxes used in machinery control differ in design according to the manufacturer. Recent changes in design have led to printed circuit board manufacturing costs being decreased, whilst in-field P.C.B. changeover practice has been increased. Design changes occur every two to three years.

DRAINAGE APPLICATION

Laser levels used for drainage application have been developed from their use in tunnelling. In 1962, a laser was first used to construct the Bart Tunnel under San Francisco Bay. The principle of a pipe laser is to direct a laser beam through optics with a collimator placed on the front of the instrument to bring the beam together. By adapting self levelling features to the unit, it can be aligned very accurately to give correct readings. Grades can be selected by dial setting, and units now incorporate micro-processors which greatly reduce the size of the level to a dimension of 140 mm in diameter and 290 mm long. The laser level used for pipe laying must perform under very demanding environmental conditions and they must survive accidental dropping. Their features include 40 per cent positive grade 15 per cent negative grade, line control to move the beam horizontally and attachments including telescopes, trivet plates and remote line control cables. High line attachments will become available in Australia as regulations change to make greater use of manhole installations. The system incorporates a telescope set on a pole above the laser to facilitate the setting on correct flow line, dial in the grade and bring the unit around to correct line at the next set-out stake or manhole. No dramatic developments are foreseen in the manufacture and use of pipe lasers.

TUNNELLING

In the 1980s tunnelling work is designed around lasers. The laser is mounted in the crown of the tunnel in a series and these are used to guide "mole" machines and other excavating and transportation machines through sensors connected to control panels.. The laser beam is stationary and pulses are not given so that solenoid valves cannot be operated. Displays indicate to the operator when to move left or right or up and down. Tunnelling lasers are of very high power and require safety restrictions not normally encountered in the construction industry.

LASER SAFETY

The introduction of lasers in the construction industry has increased worker safety and eliminated several types of hazards such as cave-ins, backfilling and site congestion. The lasers used in construction are low powered devices. They are divided into classes depending on their power rating. The "infra-red" lasers are in Class 1 and are intrinsically safe; the helium-neon lasers fall into Class 111, 111A and 111B. These lasers can cause accidental injury if viewed directly or if focussed by optical instrument onto the eye. Safety measures are under the oversight of the Ministry of Employment and Training.

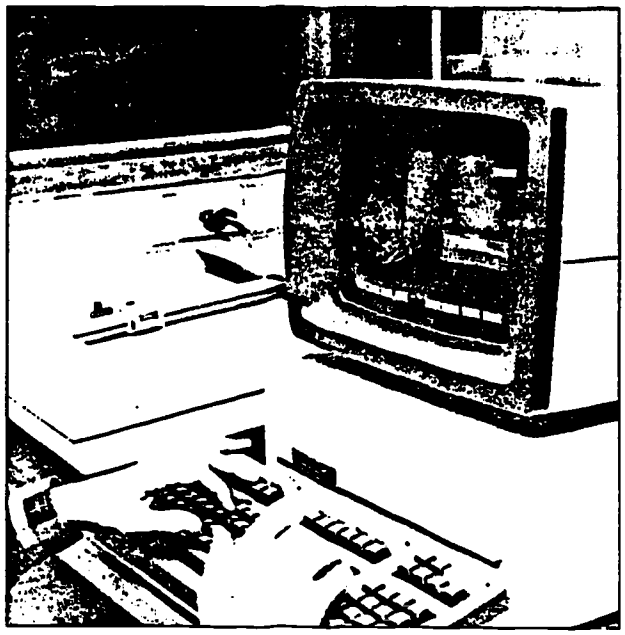
(Summary of interview with Mr. Graeme Davis, Managing Director, Spectra-Physics Pty. Ltd., Bayswater, Vic., 16 September 1984.)

USES OF MICROCOMPUTERS IN THE BUILDING INDUSTRY

Microcomputers are likely to have a far-reaching and fundamental impact on the building industry because they are relatively cheap, user friendly, increasingly powerful, versatile, portable and appropriate to the large number of small firms which make up the industry.

Possible applications are in planning and design, costing and quantities, contracting, manufacturing, statutory supervising and operation and maintenance.

Software selection will depend on individual needs, but a basic "tool kit" would include: a word processing package; an electronic spreadsheet for tabular-type calculations for estimating, design, budgets, etc; a data base management system for storing company records, materials design and cost information; and a commonly used operating system.



Demonstrating computer aided drafting on Hewlett-Packard system.

Hardware is now mainly the 16-bit microcomputer — between 128 k and 640 k (128,000 and 640,000) — with the IBM Personal Computer setting the market standard. Most manufacturers are now developing IBM PC look-a-likes. The MS-DOS system has simultaneously become the dominant operating system for these micros. The most recent hardware developments are in computer graphics.

CSIRO Division of Building Research has developed several special purpose software programs.

One is TOPMET, which is used in planning and design to solve the layout problems in two or three dimensions, e.g. single or multi-storey buildings, site layouts, regional facility layouts, manufacturing layouts.

Two programs — LAMMPS and SPACEMAT — are also used in planning. These feature a graphical output which permits more rapid comprehension of data being displayed, e.g. population figures, dwelling approvals, intra-urban migration matrices.

Other programs — FINCASH and DWELLMOD — are used in costing and quantities, which are the work of quantity surveyors and estimators.

Another CSIRO-developed program, based on the LOTUS 1-2-3 spreadsheet package, makes considerable use of graphics to display data. A life cycle costing model is used for the economic evaluation of proposed buildings at the feasibility stage.

Other sources of an increasing variety of special purpose software include building oriented software houses, industry associations and computer bureaus.

CSIRO Division of Building Research is currently involved in the field of expert systems and its integration with CAD (Computer Aided Design) software. This could be of use in the statutory supervising section of the industry (including the work of local authority planners and building regulations officers).

(Synopsis. For full paper see Sharpe, R. and Tucker, S.N., C.S.I.R.O. Division of Building Research, Melbourne. Uses of microcomputers in the building industry — making the micro revolution work for you. Invited paper delivered at ACADS/RAIA/AIQS Seminar, Perth, 10 October 1984.)

MICROPROCESSOR CONTROLLED WOODWORKING MACHINERY

> The advent of microprocessor control for woodworking machinery has made quick resetting and therefore short runs economically practicable.

This is a quotation from German consultant Gerhard Schuler at the Ligna Fair in 1983. It suggests that practices used in furniture manufacture in the 1960s and 1970s are no longer appropriate in the 1980s.

The practices of the period 1960-1970 required well stocked and comprehensive pieceparts for the economic use of machine lines. Today, furniture production has expanded greatly in design range, sizes and colour options. For example, a firm making bedroom suites in the late 1960s had three designs, each with two variations giving a total of six models. Today, the same firm has five designs, each with six variants, with a total of thirty different models.

These production trends have developed in order for firms to attract a larger slice of the market and to cater for individual needs. However, manufacturers offer this service at a very high price because production costs have rocketed.

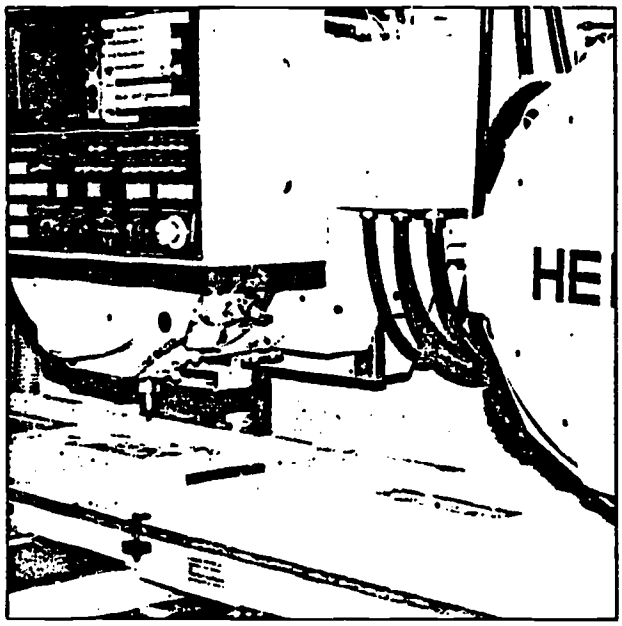
The trends of producing more individuality in furniture will continue, therefore rationalisation, new production methods and appropriate training should be introduced. But, although the process of change appears gradual and fairly simple, few firms have made the transition easily.

A close look at firms that have allowed stocks to proliferate shows significant, undesirable cost increases. These costs arise from:

- increased staff for recording, checking, sorting and issuing;
- unknown costs arising from lack of reliability of conventional recording systems;
- stacking systems, conveyors and maintenance;
- damage through transport and handling;
- incorrect planning of stock items;
- stocks, which due to changes in consumer demands, are no longer required.

The above are often hidden costs to manufacturers, which may be ignored or treated as inevitable in the highly competitive commercial situation.

The question arises: What technological and production changes are required to contain manufacturers' costs and maintain a high standard of customer service?



Heian CNC router with seven heads — useful for short runs.

Effective combination of three aspects and utilising microprocessors are essential if desired objectives are to be secured: Key aspects are in:

- Standardisation
- Processing
- Organisation

STANDARDISATION

Standardisation of components requires good production and consumer-oriented design. This may mean some compromise between the economic needs of production and the product's appearance and functional requirements of the consumer, but a designer has a great deal of scope for compromise without serious loss either to manufacturer or consumer.

Choices for the consumer can be provided in variations of style, range and colour, with minimum production changes. This is the basis of standardisation.

A good designer will consider aesthetic appearance and function as well as production details and seek to achieve standardisation in each of the following: materials, dimensions, construction and surface treatment.

Microprocessors will assist the manufacturer in reducing valuable designing, pre-planning and setting-up time, making changes to production less time-consuming and less labour intensive, with minimal disruption to the flow of the overall plant.

PROCESSING

The concept of the flow line is well known and is utilised where batch sizes are large, in order to minimise re-tooling and re-setting times. The changed market has rendered the flow line out of date, with the high demand for product variation.

To accommodate small batch sizes, it is now essential to be flexible in manufacturing processes. This means that re-tooling and setting-up times are much more significant, accounting for a higher proportion of production time. These times have to be minimised if production costs per component are to be minimised.

Setting time relates to three main procedures:

- dimension setting — cutting to length or width, drilling pattern or routing;
- working head adjustments — up and down movement of cutting or drilling depth;
- cutting tool changes — drilling, sawing or routing.

Whilst some machines, such as double sided edgebanders, dimension saws and tenoners are numerically controlled, future scope exists in drilling to minimise setting time for different drilling patterns. There are machines on the market offering near zero setting-up time.

ORGANISATION

The organisation of machines is vitally important and can be assisted by microprocessors in plant layout, costing and quantities, work scheduling, machine operations and plant maintenance.

CONCLUSION

The points outlined in this paper are relevant to large and small furniture manufacturers. The application of microprocessors in furniture production, making quick re-setting, and therefore, short runs economically practicable, is directly relevant to trade needs in Australia in the 1980s.

(The foregoing is based on a report by David, J. and Tormey, R., **Technological Change in the European Furniture Industry and Developments in Technical Teacher Training and Technical Colleges.** Hawthorn Institute of Education, 1983.)

PVC IN WINDOW JOINERY

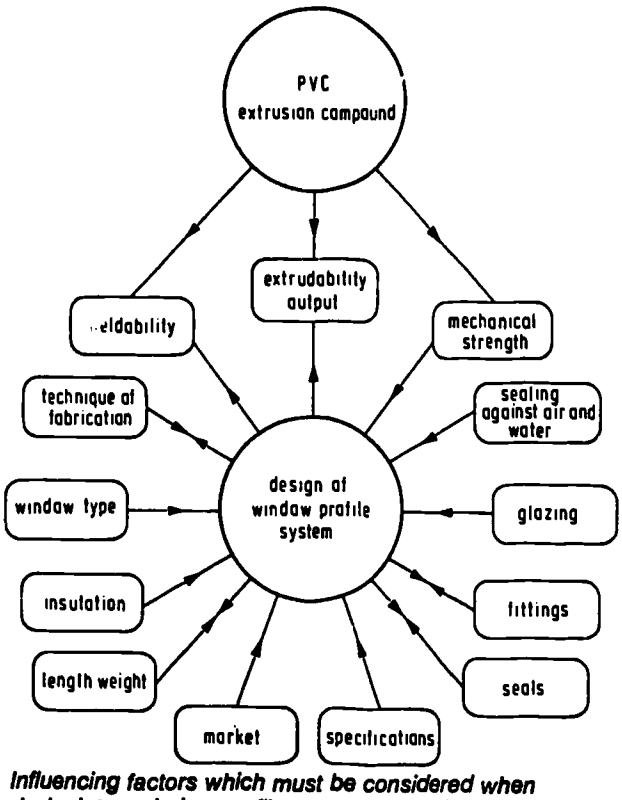
Plastic window frames have been in use since about the mid 1950s, and, currently, many architects and builders are selecting PVC window profiles.

A recent study from Europe by Sirlereaux and Loewen on the design and construction of PVC window profiles notes that the proportion of PVC windows in the total window market of West Germany is now about 40 per cent, and it is anticipated that in the coming years the proportion will increase to over 50 per cent.

The writers attribute this success to the excellent properties of the PVC window against those of comparable materials:

- they are maintenance free,
- have good thermal insulation,
- are not liable to distortion,
- have a high ageing resistance,
- do not encourage the formation of condensation.

Sirlereaux and Loewen also outline factors to be considered when designing a plastic window profile and stress that these properties are achieved with the most economical of the bulk plastic materials — PVC.



Influencing factors which must be considered when designing a window profile system in plastic.

Further, the writers list material selection criteria, noting that a comprehensive evaluation has demonstrated the advantages of PVC as the profile raw material:

- price;
- ageing resistance, which must be adjusted to correspond to the climatic conditions of the region where the window is likely to be installed;
- rheological behaviour which determines the material flow, the die swell and the surface quality amongst others;
- extrudability by which the questions of "plate out" and thermal stability are encompassed;
- processability range, i.e. a small change in the finished product properties resulting from different extrusion conditions;
- material mechanical properties such as thermal deformation resistance, stiffness, impact strength, weldability, etc.

Sirlereaux and Loewen's report concludes with technical discussion on the shape and construction of the extrusion dies and the cooling (calibration) system which determines the selection of PVC raw materials and the quality of window profiles.

(See Sirlereaux, S. and Loewen, K.W. "The design and construction of PVC window profiles." **German Plastics (Kunststoffe)**, Vol. 73, January 1983, pp 6-7 English text, pp 9-12 German text.)

TRENDS TOWARDS PLASTIC WINDOW FRAMES

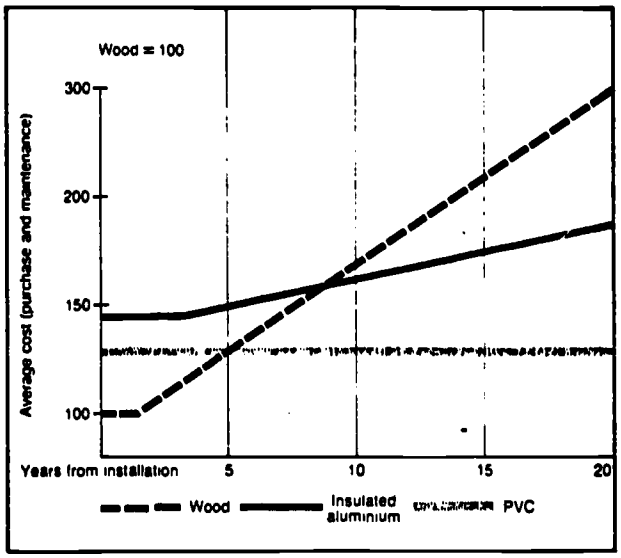
A promising future can be predicted for PVC window frames if for no other reason than their economy.

An article by G. Rekers of Wavin BV, Hardenberg, the Netherlands, discusses the development of plastics window systems in Europe, pointing out that because windows and panes account for about 7 per cent of overall building costs, long-term saving by using PVC window frames is a great attraction.

The writer gives a comparison of costs of PVC, wooden and aluminium window frames, underlining that although their initial price is greater, PVC frames are eventually much more economic because they are maintenance free.

As well as noting market trends in the Netherlands, Rekers outlines trends in West Germany and the U.K., predicting an increasing use in PVC window frames' market share.

(See Rekers, G., "PVC window frames: a promising future," **Shell Polymers**, Vol. 8, No. 2, 1984, pp 52-4.)



Comparison of costs and materials' lasting properties.

ABSTRACTS

LASER CUTTING AND MACHINING

Habercom, G.E. Laser cutting and machining: non metals, 1970-June 1980 (Citations from the Engineering Index Data Base.) (Rept. for 1970-June 1980. National Technical Information Service, Springfield, VA. July 1980.)
144 pp microfiche
139 citations

Reports cited describe techniques for electrothermal cutting and machining of glass, fabrics, wood, plastics and other non metal products by use of controlled laser beams, also results of thermal analysis of materials exposed to laser beams.

Hoffman, M. Messer Griesheim. "High-precision profile cutting with the CO^2 laser." Reprint 33/76e from **Chemie-Technik**, 5/76 Huthig Verlag, Heidelberg.
4pp (A4)

High-precision profile cutting, clean, burr-free cutting kerfs, fast operating speeds and savings of material are some of the advantages of cutting with CO^2 gas lasers mounted on fully automatic guiding machines. The potential applications of this cutting technique range from steel sheet to glass, asbestos, wood, leather, fabrics and plastics. The efficiency of the CO^2 gas laser for cutting plastics of all types is illustrated in a table — polyethylenes, polypropylenes, acetalcopolymers, polyester, PVC-impact resistant, acrylic glass (perspex), hostapor lightweight concrete, asbestos cement.

Messer Griesheim. "Economic cutting with CO^2 lasers." Reprint 6/75 from **Schweissen und Schneiden**. Vol. 3/75 published by DVS-Verlag Dusseldorf.
4pp (A4)

CO^2 lasers, operated in conjunction with such mechanical systems as co-ordinate drive, are used on production work in West German plants. The primary field of application involves profile cutting of thin metallic and non-metallic sheets in small repetition runs. A table illustrates values

achievable with a 200 W CO^2 laser (low mode order) with the following materials: steel sheet — galvanised on both sides. 18/8 chrome-nickel steel, titanium alloy, perspex-impressed, perspex-transparent, polypropylene. polystyrene, PVC-high density, glass fibre reinforced plastic, polyester carpet, felt carpeting. nylon, cotton fabric-multi layer, plywood, aluminium oxide, quartz glass.

Smith, G. "Laser Applications." Advances in Industrial Laser Technology (Seminar). The Royal Exhibition Building, Carlton, 5 August 1983.
7 pp (A4)

Lasers have become very versatile instruments. Perhaps no other scientific instrument has found such widespread use. The versatility of the laser is due to its wide ranging and special optical properties, in particular
1. Narrow collimated beam
2. Narrow spectral band-width
3. High coherence
4. Very wide range of powers
5. Very wide range of pulse lengths ranging from continuous wave to ultra-short temporal pulses.

These properties are discussed, including their respective applications in fields such as: industrial cutting, welding, etc.; laser erasing; medical-retinal detachments; photo-coagulation; surface destruction of tissue; alignment; surveying; visual refraction; surface vibration; vibration analysis; surface contouring; distance measurement and range finding; high speed photography.

PVC WINDOW JOINERY

Neudell D.H., "PVC Window Profiles: Getting the Technology Together." **Plastics Technology**, Vol. 28, No. 2, February 1982, pp 64-68.

The challenge to increase productivity and profitability encompasses every aspect of window profile production. In this article the author indicates what is happening in the all important areas of resins and additives. A brief look is taken at the best equipment, dies and on-stream equipment to produce such profiles.

"PVC simplified window design, fabrication." **Modern Plastics International**, Vol 14, No. 4, April 1984, p 30.

The design factor and time to fabricate are discussed. The weight factor and time to assemble are important features to those interested in producing a PVC system window. Cross sectional drawings of profiles are given.

Vowinkel, H., "The processing and joining of hollowed chambered profiles made from modified PVC." **German Plastics (Kunststoffe)**, Vol. 73, March 1983, pp 4-6 English text, pp 118-122 German text.

This article covers the complete manufacture of PVC window profiles and fabrications, including material, mechanical processing, milling, heat shaping (bending of arches), painting methods and finishing of welded joints. German text gives illustration on production method and testing procedures for corner welds. Should be of value to joiners in particular.

T E C H info

TECHNOLOGICAL CHANGE INFORMATION FOR TAFE TEACHERS

Technological Change Monitoring Unit for This Issue

Co-ordinator:
Barry Brinkworth, Centre for Teaching in Applied Technology, Hawthorn Institute of Education

Monitors:
John David, Department of Furniture and Related Technologies, Hawthorn Institute of Education;

Geoff Rodgers, Department of Building Technologies, Hawthorn Institute of Education;

Richard Verity, Department of Material Technologies, Hawthorn Institute of Education.

Editor:
Ken Eckersall, Investigation and Development Unit, Hawthorn Institute of Education.

Design:
Helen Kemp, Hawthorn Institute of Education

For further information, address all enquiries to Hawthorn Institute of Education, 442 Auburn Road, Hawthorn, 3122, Victoria. (03) 818 0631.

Enquiries may be directed to the Unit Co-ordinator or the relevant Monitor.

Grateful thanks are extended to contributors from industry to this publication.

Hawthorn
Institute of Education
442 Auburn Road, Hawthorn, Vic. 3122, Australia. Telephone 818 0631 / 819 4699 Telex AA37985 HAWCOL

March 1985

MONITORING TECHNOLOGICAL CHANGE PROJECT

To Teachers in Building and Furniture Industries

The TAFE National Centre for Research and Development is currently undertaking a pilot study with Hawthorn Institute of Education aimed at monitoring technological change.

The main purpose of the project is to gather information about new technologies and processes used in industry and commerce; and to provide TAFE teachers (Trade/Technician teachers in particular) on an Australian wide basis with the latest information and resource data.

The enclosed newsletter - TECH INFO - is an outcome of material gathered from our pilot investigation, relevant to your industrial field and we are anxious to know about its usefulness to you as a TAFE teacher.

We would be grateful if you could complete the attached questionnaire to enable us to further develop and improve future newsletters appropriate to your specific needs.

Enclosed is a postage paid return envelope for your convenience and we would appreciate your return by April 4 to enable the most effective processing of your comment.

Thanking you in anticipation.

Barry Brinkworth,
PROJECT CO-ORDINATOR

BB:ld

MONITORING TECHNOLOGICAL CHANGE PROJECT

Q.U E S T I O N N A I R E

Please complete the questionnaire and return it in the reply paid envelope.
Your name is not required.

1. Please place a tick on the rating scale 1 to 5.

		LOW 1 2 3 4 5 HI(
1.1	How do you rate the usefulness of Tech Info as a technological change information source?	
1.2	How do you rate the quality of presentation of the Tech Info newsletter?	
1.3	To what extent did you find the Tech Info newsletter interesting?	
1.4	To what extent do you find technical magazines useful as sources of technological change information?	
1.5	To what extent do you find technical books useful as sources of technological change information?	
1.6	How do you rate the usefulness of abstracts as sources of technological change information?	
1.7	How do you rate trade brochures and pamphlets as sources of technological change information?	

2. Please tick the box "yes" or "no" or "undecided".

		YES	NO	UNDECID.
2.1	Would you like to receive future Tech Info newsletters?	☐	☐	☐

PLEASE TURN OVER

2.2 Would you use a "phone-in" computer service for obtaining technological change information if one were available?

YES	NO	UNDECIDED
☐	☐	☐

3. Please place a number from 1 to 5 against the items below, showing what you think are the most useful features of a technological change information service.

- ☐ summarised journal articles
- ☐ summaries of interviews
- ☐ details of where to find information (abstracts)
- ☐ original articles written by technical specialists
- ☐ data such as tables, charts, graphs

4. Please add any comments or suggestions.

5. Please indicate your teaching area, e.g., carpentry and joinery, cabinet making, bricklaying, middle-level building studies.

Thank you for your co-operation.

TECH INFO BULLETIN - TAPE TEACHERS' RESPONSES

NOTES: 1) DATA FROM ALL RETURNS (TOTAL 169)
2) PERCENTAGE FIGURES IN BRACKETS
3) NON-RESPONSES NOT INDICATED

MONITORING TECHNOLOGICAL CHANGE PROJECT

Q U E S T I O N N A I R E

Please complete the questionnaire and return it in the reply paid envelope.
Your name is not required.

1. Please place a tick on the rating scale 1 to 5.

		LOW (1)	(3)	(17)	(40)	(40) HIGH
1.1	How do you rate the usefulness of Tech Info as a technological change information source?	3	5	28	67	68
		1	2	3	4	5
		(0)	(3)	(12)	(40)	(47)
1.2	How do you rate the quality of presentation of the Tech Info newsletter?	1	5	21	67	79
		1	2	3	4	5
		(3)	(3)	(19)	(51)	(24)
1.3	To what extent did you find the Tech Info newsletter interesting?	6	6	33	87	41
		1	2	3	4	5
		(0)	(10)	(14)	(36)	(37)
1.4	To what extent do you find technical magazines useful as sources of technological change information?	1	17	24	61	63
		1	2	3	4	5
		(6)	(24)	(40)	(22)	(13)
1.5	To what extent do you find technical books useful as sources of technological change information?	11	41	67	38	22
		1	2	3	4	5
		(5)	(14)	(27)	(39)	(15)
1.6	How do you rate the usefulness of abstracts as sources of technological change information?	8	23	46	66	26
		1	2	3	4	5
		(0)	(4)	(15)	(44)	(36)
1.7	How do you rate trade brochures and pamphlets as sources of technological change information?	1	7	26	75	62
		1	2	3	4	5

2. Please tick the box "yes" or "no" or "undecided".

		YES	NO	UNDECIDED
2.1	Would you like to receive future Tech Info newsletters?	156	4	9
		(92.3)	(2.4)	(5.3)

PLEASE TURN OVER

2.2 Would you use a "phone-in" computer service for obtaining technological change information if one were available?

YES	NO	UNDECIDED
87 (51)	27 (16)	55 (32.5)

3. Please place a number from 1 to 5 against the items below, showing what you think are the most useful features of a technological change information service.

Lowest — Low 1 2 3 4 5 High Ratings (Raw Scores) — Highest

1		46	37	29	41	17	summarised journal articles
3		11	23	43	48	38	summaries of interviews
2		26	46	32	37	31	details of where to find information (abstracts)
		45	20	30	29	37	original articles written by technical specialists
4		14	16	37	40	57	data such as tables, charts, graphs

4. Please add any comments or suggestions.

(Refer attached sheets for written comments.)

COLLATED RANKINGS

		Ratings 1 + 2 (Lowest)	Ratings 4 + 5 (Highest)	
Lowest	1	83	58	1
	3	34	86	3
	2	72	68	2
		65	68	
Highest	4	30	97	4

Note: Same order for both groups.

5. Please indicate your teaching area, e.g., carpentry and joinery, cabinet making, bricklaying, middle-level building studies.

TOTALS: CARPENTRY (72) FURNISHING TRADES (54) MIDDLE LEVEL (43).

Thank you for your co-operation.

TECH INFO BULLETIN : QUESTIONNAIRE RESPONSES TO OPEN QUESTION 4

POSITIVE COMMENTS

* Tech Info fills the hole that is missing in teaching of C & J (3)
* Very good publication (2)
* Hope it's not a once-off publication
* Any current information is useful for keeping up-to-date
* Good idea (2)
* Very professional
* Phone-in service very useful (3)
* Keep up the good work (5)
* Excellent - we need more of this
* Very good - should be more of it (5)
* There has been a need for this type of newsletter for a long time.
* Would be interested in future copies
* Excellent - greatly appreciated in Queensland (2)
* Well presented
* Computer base most useful
* Excellent - congratulations (8)
* Must be encouraged - hope it continues
* I would be prepared to subscribe
* Good idea for students as well (2)
* Similar to CSIRO newsletter Rebuild (2) (complements this)

NEGATIVE COMMENTS

* Of no real value to cabinet making - we are well enough informed (3)
* Information already available by other magazines
* Information should be the latest, not six months old
* Needs to be more specific for wood machinery teachers

SUGGESTIONS

* Original articles are too heavy
* Itemised contents sheet for future use (2)
* Welcome monthly abstracts
* Double sheets (mat 6) so that it can be kept in a folder (2)
* More photographs
* More information could be provided - follow up in-depth information
* Manufacturers should provide more information
* Teachers will require re-training (2) (first-hand experience needed) - invite outsiders to contribute as well
* Accept articles sent in by others (3)
* More information (2)
* Handy to have back-up video tapes (3)
* TV programs like Towards 2000 best source
* More abstracts
* In book form - easy to put in folder (2)
* Loose leaf sheets to enable filing
* Better photos - blow ups - exploded views
* Teachers need on-site training (2)
* It's difficult to obtain information on new equipment (manufacturers reluctant to provide this)
* Colleges should lease up-to-date equipment
* More about new technologies in Australia
* Please send copies to Furniture Trades Association of NSW (attitude and actions about 50 years behind)
* More information on where we can attend lectures about new technology

(Bracket figure represents numbers of similar comments.)

TECHNOLOGICAL CHANGE INFORMATION FOR TAFE TEACHERS

Published by Hawthorn Institute of Education for the TAFE National Centre for Research and Development

Newsletter to TAFE Authorities Vol.1, No.1, 10 April 1985

MONITORING TECHNOLOGICAL CHANGE PROJECT

This newsletter introduces a national pilot project with the potential to provide central TAFE authorities, TAFE regional groups and colleges of TAFE, as well as TAFE teachers, with the latest, relevant technological change information for assisting staff development, curriculum development, facilities and program planning and program delivery.

The project was commissioned by the TAFE National Centre for Research and Development and is being carried out by Hawthorn Institute of Education with collaboration from industry and TAFE.

Its objectives were to devise an appropriate means of monitoring technological change in industry and commerce, and reporting new technologies, materials and processes to TAFE teachers and TAFE authorities. A monitoring grid has been designed, some trial networks have been established, and the products of the monitoring trials have been processed for reporting. For the pilot project, the grid was trialled with the building and furniture industries, and reporting has been targeted on TAFE trade and technician teachers in those areas.

The enclosed Tech Info bulletin is a product of the pilot project. It has now been circulated to a sample of TAFE teachers in all states for evaluation, and there are indications of a very positive response.

The project team is currently exploring the possibility of using electronic information technology (such as computer data banks and videotex) to provide more immediate access to data gathered through the monitoring process.

The purpose of the present newsletter to TAFE authorities is two-fold:

- to draw this national project and future plans to your attention, and
- to seek your opinions and suggestions concerning the scheme, and the services it might provide for reporting technological change information to TAFE teachers and authorities.

...2

Such services could include:

- a regular Tech Info bulletin for a variety of specialist industry/commerce TAFE groups (possibly annotated to suggest some implications), leading to future videotex (immediate access) dissemination;

- a technical information service - information about new materials, process and products, and trends in fields such as building, engineering, transport, communications and energy utilisation, would be retrievable from a central computer system;

- an abstracting service, which would précis technical information and identify its source;

- an alerting service, that would investigate and identify industrial and commercial trends or changes;

- a product, equipment and instrument listing service, that would identify manufacturers and/or suppliers and provide information for workshop and laboratory requirements;

- an analysis service, which would study, analyse and report on technological changes and their relevance to particular TAFE groups.

The project team is particularly keen to know your opinion of Tech Info, what suggestions you have for the future of the scheme, and how you would rate the usefulness of the various services listed above, if such were available.

Would you please complete the attached questionnaire and return it in the stamped self-addressed envelope by Wednesday 24 April 1985.

Thanking you in anticipation.

Kind regards

Barry Brinkworth
Project Officer

MONITORING TECHNOLOGICAL CHANGE PROJECT

QUESTIONNAIRE

Please complete the questionnaire and return it in the stamped self-addressed envelope.
Your name is not required.

1. Please indicate with a tick your field of responsibility:

Staff development _____

Curriculum _____

Facilities planning _____

Field services _____

Policy and planning _____

Other (please specify) _____

2. Please place a tick on the rating scale 1 to 5

How do you rate the usefulness of the following services, if such were available?

		High				Low
2.1	A Tech Info bulletin (for teachers) and with annotations (for authorities)	1	2	3	4	5
2.2	A "dial in videotex" service	1	2	3	4	5
2.3	A technical information service based on a central computer system	1	2	3	4	5
2.4	An abstracting service	1	2	3	4	5
2.5	An alerting service	1	2	3	4	5
2.6	A product, equipment and instrument listing service	1	2	3	4	5
2.7	An analysis service	1	2	3	4	5

(Please turn over)

3. Please add any comments or suggestions

(a) about the Tech Info bulletin to TAFE teachers;

(b) about the future of the scheme.

Thank you for your co-operation.

Returns W.A. (2)
QLD (1)
S.A. (2)
TAS (1)
NSW (1)
Total 7

MONITORING TECHNOLOGICAL CHANGE PROJECT

QUESTIONNAIRE

Please complete the questionnaire and return it in the stamped self-addressed envelope.
Your name is not required.

1. Please indicate with a tick your field of responsibility:

Staff development	4
Curriculum	2
Facilities planning	2
Field services	3
Policy and planning	3
Other (please specify)	1

2. Please place a tick on the rating scale 1 to 5

How do you rate the usefulness of the following services, if such were available?

		High				Low
2.1	A Tech Info bulletin (for teachers) and with annotations (for authorities)	(4)	(1)	(2)		
		1	2	3	4	5
2.2	A "dial in videotex" service	(2)	(4)	(1)		
		1	2	3	4	5
2.3	A technical information service based on a central computer system	(3)	(3)	(1)		
		1	2	3	4	5
2.4	An abstracting service	(1)	(4)	(2)		
		1	2	3	4	5
2.5	An alerting service	(3)	(1)	(3)		
		1	2	3	4	5
2.6	A product, equipment and instrument listing service	(2)	(3)	(2)		
		1	2	3	4	5
2.7	An analysis service	(4)	(2)		(1)	
		1	2	3	4	5

(Please turn over)

3. Please add any comments or suggestions

(a) about the Tech Info bulletin to TAFE teachers;

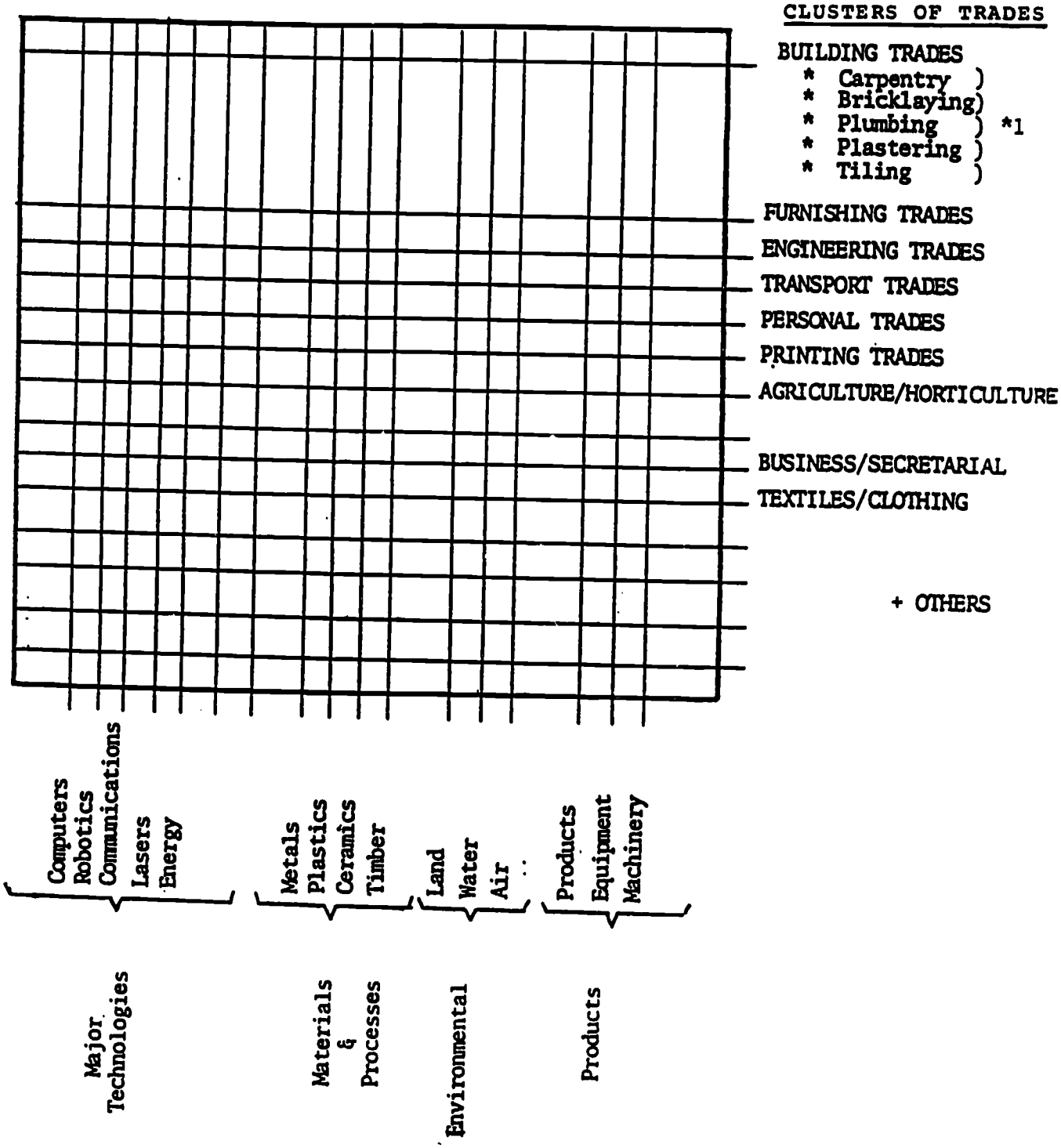
Good, although distribution network would have to be carefully considered - an excellent idea - I have had a number of staff groups complain that they are unable to access information re technical change in their area; or that it comes too late to act upon: I'm sure that any system to make information available would be very well received - very good -

(b) about the future of the scheme.

Has great potential, but success depends on how well it is put into practice - Would be happy to promote the idea amongst teaching staff - Needs to be wide ranging to be successful

Thank you for your co-operation.

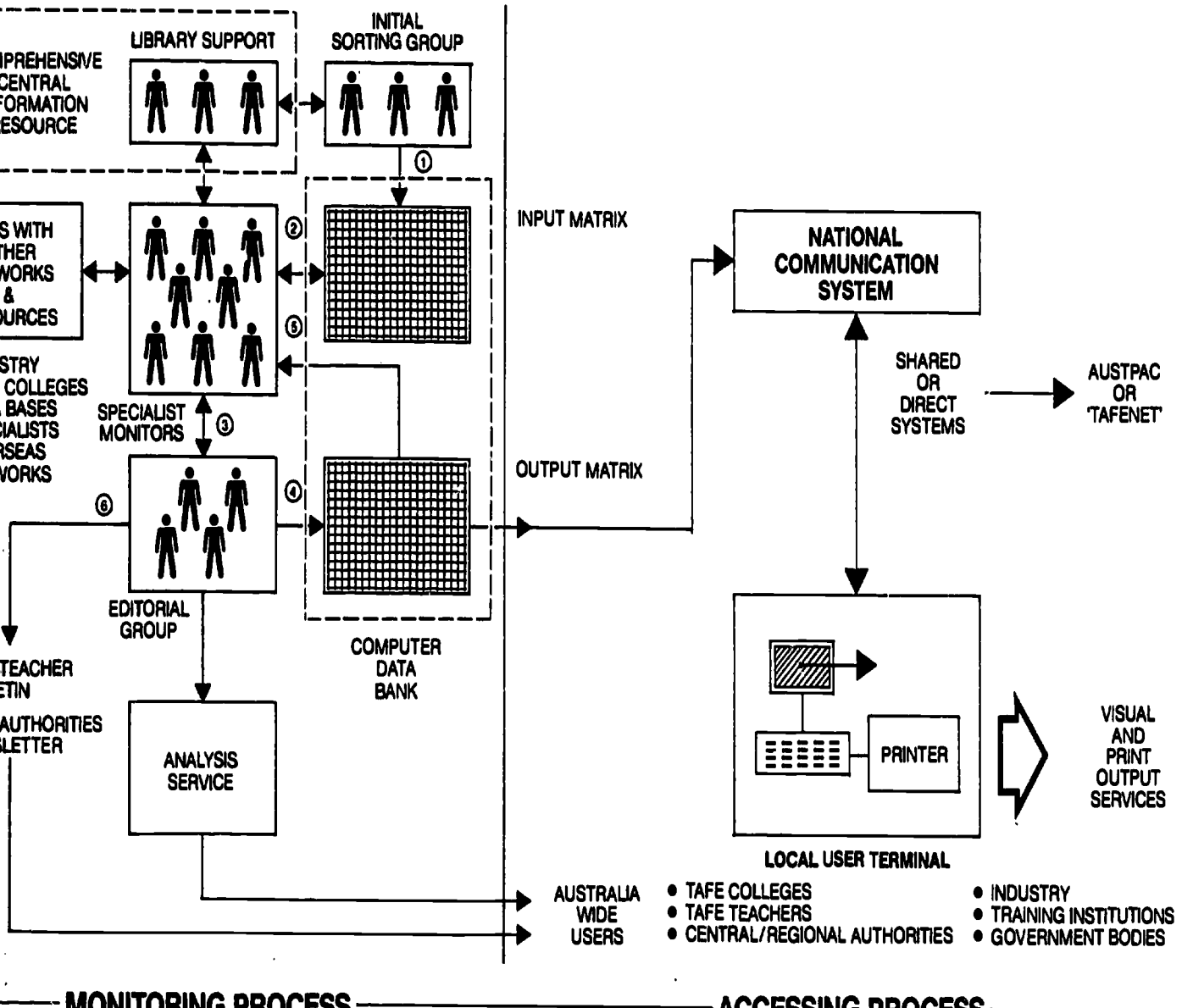
INFORMATION MATRIX



NOTE * 1. Each row represents a number of individual trade areas.

* 2. Both row and column categories are examples only.

A SCHEME FOR MONITORING TECHNOLOGY & TECHNOLOGICAL CHANGE



APPENDIX G

A SCHEME

for

MONITORING TECHNOLOGICAL CHANGE

and

REPORTING TO TAFE TEACHERS, AUTHORITIES, ETC.

Developed by Hawthorn Institute of Education
on the basis of a project commissioned by the
TAFE National Centre for Research and Development Ltd.

A SCHEME FOR MONITORING TECHNOLOGICAL CHANGE

1. BACKGROUND

This scheme was developed from the pilot study project, Monitoring Technological Change, commissioned by the TAFE National Centre for Research and Development, in which a sample monitoring process was designed and trialled.

The scheme is designed to reduce duplication of effort by many TAFE Authorities, officers, and teachers at all levels; to co-ordinate a network of specialist expertise; and to provide a comprehensive national service, available in an acceptable format in the user's local environment, for the same unit cost anywhere in Australia.

During the course of the investigation, on the advice of the project steering committee, a document outlining this scheme was prepared for submission to TAFE Authorities. That document included 'indicative costs' for an alternative staged scheme, based on the assumption that a considerable part of the total costs could be absorbed by utilising the existing resources and networks of Hawthorn Institute of Education. However, once the investigation was completed, it became apparent that the level of cost saving would not be practicable, given the anticipated volume of demands, especially on staff and holdings of the central resource facility for the scheme. (Nevertheless, Hawthorn's resources and experience would probably provide the best basis for efficient development of the scheme.) Updated preliminary cost estimates are given below on page 72.

2. THE SCHEME

2.1 Overview

The scheme to monitor technology can best be explained by separating it into two main processes:

2.1.1 A monitoring process which collects, sorts, interprets, develops and produces technological information for a computer data base via an editorial group, who translate the information into a number of services developed for identified client groups.

2.1.2 An accessing process which can retrieve information from the central data base via a variety of service options. Access would be from a local 'intelligent' users' terminal, utilising a national communication grid system. Information would be available in videotex form or permanently recorded in print, from a local user terminal printer, making the information both immediate and readily available anywhere in Australia.

These processes are illustrated in Figure 1:

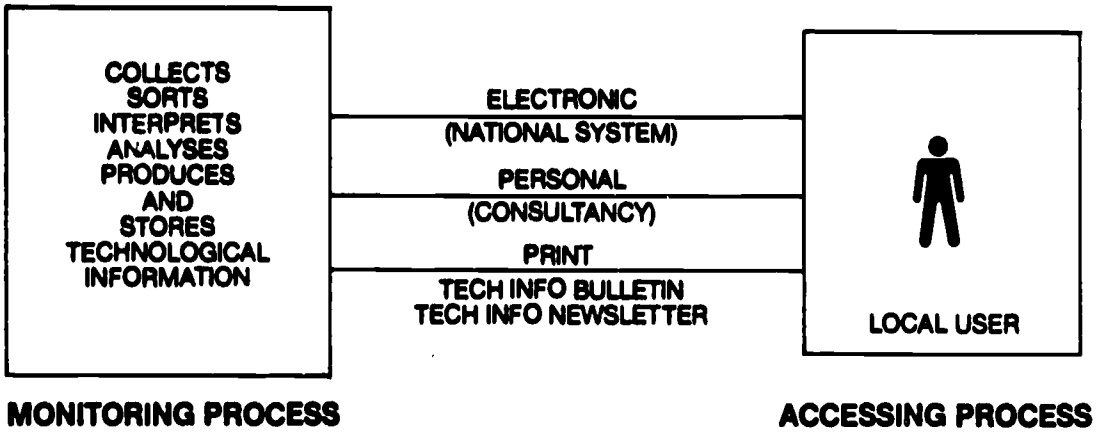


Figure 1. Overall Scheme

2.2 The services

The service options from a printed source, which in time might be replaced by a videotex and graphic facilities, would be:

2.2.1 A regular Tech Info bulletin for each cluster group of specialist industries/commerce TAFE teacher groups (possibly annotated to suggest some implications). See Tech Info, Vol. 1, No. 1, Feb. 1985 for an example publication.

2.2.2 A regular Tech Info newsletter to TAFE Authorities to alert them to particular technological changes and possible implications for planning, curriculum, staff development and resourcing.

The service options available from the system's computer data base would be:

2.2.3 An abstracting service, which would provide summarised technical information together with source identification.

2.2.4 A technical information service, which would provide information about new materials, processes, products and new technology in fields such as building, engineering, transport, communications and energy utilisation.

2.2.5 An alerting service, which would investigate and identify industrial and commercial trends or changes.

2.2.6 A product, equipment, machinery listing service, which would identify manufacturers and/or suppliers and provide information for workshop and laboratory requirements.

2.2.7 An analysis service which would study, analyse and report on technological changes and their relevance to particular TAFE groups or investigate specific enquiries on a consulting basis.

2.3 Monitoring process

The flow diagram below, which indicates the major stages and/or sequences of the monitoring process, should be read in conjunction with the description which follows:

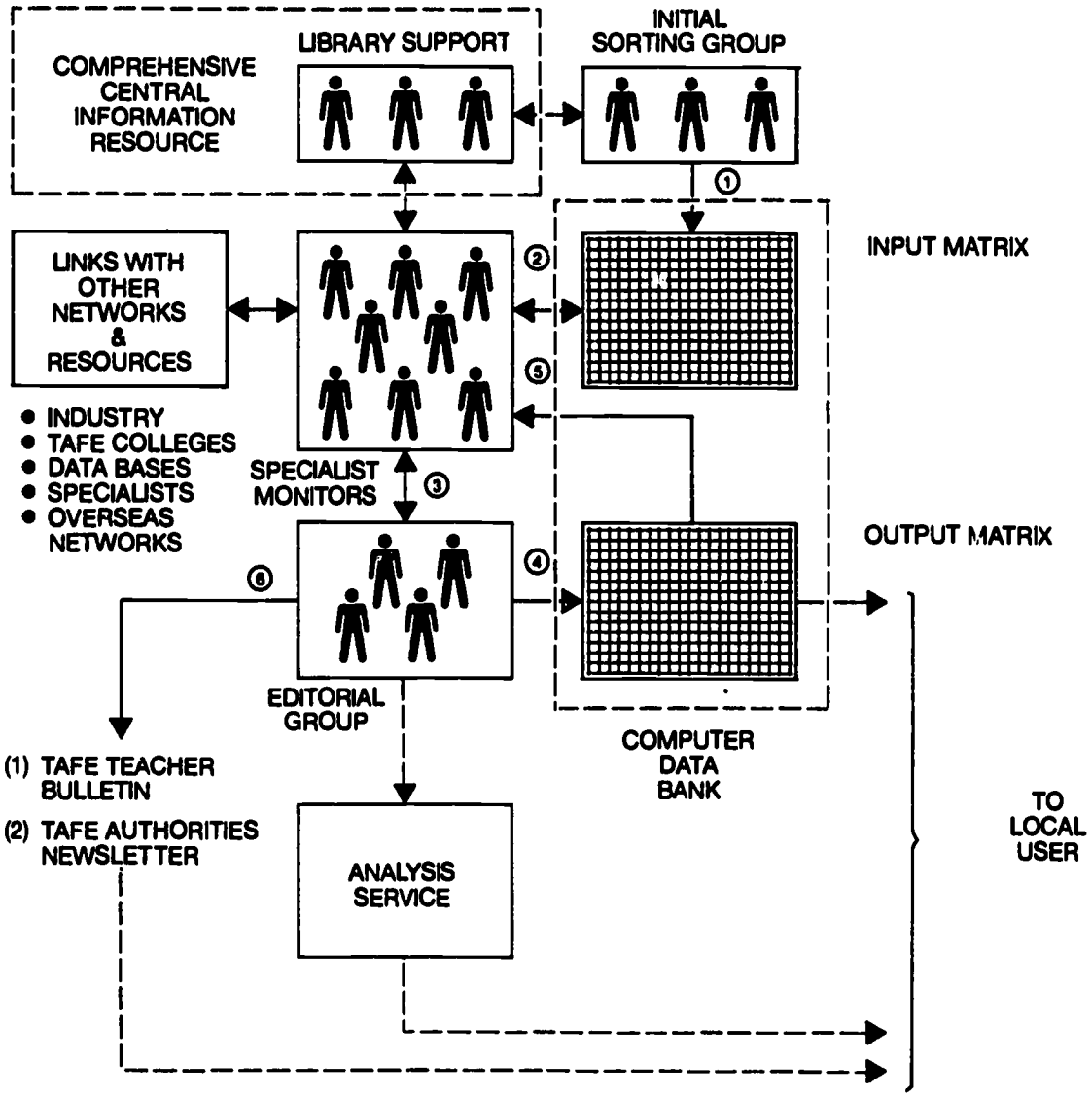


Figure 2. Monitoring Scheme

2.3.1 Sequence 1

Information from journals, magazines, trade papers and booklets, newspapers and other similar resource materials from the areas shown as columns on the information input matrix will be gathered with library assistance, sorted and recorded in the computer input matrix. The material will be sorted initially by non-specialist personnel into the categories shown as rows on the matrix.

2.3.2 Sequence 2

After the initial sorting process, information is drawn from the computer by specialist monitors, who concentrate on their particular clusters, and further monitoring is achieved by reading follow-up articles and tracing more information from trade/industrial journals. The specialist monitors will also draw on other 'expert' resources and data information networks. As well as influencing their output in Sequence 3 (below), some of their additional information may be stored in the input matrix. The contents of the input matrix will be regularly reviewed, especially in the light of the content of the output matrix, and obsolete items will be archived or deleted.

2.3.3 Sequence 3

The information from the specialist monitors is then processed through the editorial group, whose major responsibilities will be to select, clarify, stylise and refine material into the format required for the retrieval service options and to ensure quality control over the output data.

2.3.4 Sequence 4

The output from the editorial group will be recorded in the output matrix of the computer data bank and stored so that external outputs can be retrieved from either the horizontal or vertical axis parameters.

2.3.5 Sequence 5

The specialist group will have reader access to the output matrix but input is only possible through the editorial function.

2.3.6 Sequence 6

A further task for the editorial group will be to develop, produce and distribute Tech Info bulletins to TAFE teachers and Tech Info newsletters to TAFE Authorities. These will possibly be phased out after full implementation of the scheme, since information would then be immediately accessible on videotex.

2.4 Accessing process

Users of the services provided will obtain access to the technology information from regular print materials (the bulletin or newsletter), an analysis service, or electronic enquiry through their own local terminal, which would be connected via a national telephone grid and interfaced with the central computer data bank shown in the monitoring process.

Using the electronic access system, individual users would be able to key into the system using an identification code and receive direct information from the services selected. Costing for such service would need to be the same for anywhere in Australia to ensure equality of access, and financial support for this facility would require central funding - say $20,000 annually.

To reduce the on-line costs, the local user's terminal needs to be an 'intelligent' device to store substantial data. This will enable information, after it has been identified, to be sent down the line at a quick, non-interrupted rate and stored in the memory of the local user's terminal. The users will then be able to read and/or print the information in their own time frame and not pay for extra on-line time during this activity. Another reason the local terminal needs to be 'intelligent' and have extra storage capacity is to enable it to receive and reproduce graphic information.

3. IMPLEMENTATION

3.1 Implementation in full

If implemented in full, the monitoring process should be extended to accommodate 10 trade 'clusters', each receiving two Tech Info bulletins per year.

It should be stressed that, on the basis of experience from the pilot project, we believe that the main information resource for the project (both print and on-line) ought to be located alongside the monitoring and editorial functions: other solutions are much less efficient.

In the first year of operation, a study should be made of the electronic information transfer and capabilities of potential users, especially colleges, and the characteristics and capacities current and planned networks ought to be studied that the most appropriate system can be adopted providing on-line access to outputs from the monitoring system.

3.2 Implementation by stages

An alternative to immediate full implementation would be to introduce the scheme by stages.

To illustrate this possibility we shall assume that:

(a) the scope of monitoring/reporting is gradually increased from four 'clusters' in the first year to 10 in the fourth, and

(b) electronic storage, sorting and reporting of information are delayed until a fifth stage.

With regard to scope, it is suggested that in Stage 1, as well as building trades and furnishing trades (continued from the pilot study), engineering trades and transport trades be added, and that monitoring focus on such across-trade elements as computers, robotics, energy use, and materials. For stages 2 to 4, additional clusters and additional focal points for monitoring would be determined in the light of needs.

3.3 Indicative cost estimates

Indicative cost estimates for full and staged implementation are shown in the table on page 72. Although these estimates have been arrived at in the light of experience with the pilot project they are not the result of a rigourous costing and forecasting process. They should therefore be taken as indicators and not as confident predictors.

TABLE 1

PRELIMINARY COST ESTIMATES

	Year 1	Year 2	Year 3	Year 4	Year 5
'CLUSTERS' SERVED					
Full Scheme	10	10	10	10	10
*Staged Scheme**	*4*	*6*	*8*	*10*	*10*
COSTS ($'000)**					
Monitoring & Preparation					
Inform'n Res'ce***	32	25.9	28.0	30.2	32.7
	15	*15.1*	*23.3*	*30.2*	*32.7*
Library Staff	52	56.2	60.7	65.5	70.7
	21	*33.5*	*49*	*65.5*	*70.7*
Specialist M'trg	60	64.8	70	75.6	81.6
	24	*38.9*	*56*	*75.6*	*81.6*
Editorial Group	72	77.8	84	90.7	98
	20	*27*	*35*	*50.4*	*98*
Computer Support	35	37.8	40.8	44.1	47.6
	-	-	-	-	*47.6*
Other	30	32.4	35	37.8	40.8
	12	*19.4*	*28*	*37.8*	*40.8*
Dissemination					
Teacher Bulletins & Authority Newsl'trs	30	32.4	35	37.8	40.8
	13	*20.5*	*29.2*	*37.8*	*40.8*
On-line Access	20	21.6	23.3	25.2	27.2
	-	-	-	-	*27.2*
TOTALS	331	348.8	376.7	406.9	439.4
	105	*154.4*	*220.5*	*297.3*	*439.4*
ANNUAL INCREASE	331	17.8	27.9	30.2	32.5
	105	*49.4*	*66.1*	*76.8*	*142.1*

* Figures in *italics* indicate staged implementation estimates
** Includes escalation at 8 per cent per annum
*** Includes storage ($8th) as a capital cost

4. CONCLUSION

Responses to the pilot project were highly favourable, and valuable additional services could be provided by this extended scheme. Estimates suggest that the scheme, in one form or another, would be well within affordable limits, provided that action were taken promptly at national level, rather than piecemeal by separate States independently.

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